S 2
Aim
Room 2nd floor
IS

PUBLIC LIBRARY
MAR 20 1963
DETROIT

# NUCLEAR SCIENCE ABSTRACTS

Volume 17 Number 4
Abstracts 4374–5653

February 28, 1963

UNITED STATES ATOMIC ENERGY COMMISSION
Division of Technical Information

# USAEC DEPOSITORY LIBRARIES

Collections of USAEC reports are maintained in the libraries of the organizations listed below for reference use by the general public. Facilities for making photocopies are available. The USAEC also makes available through these libraries atomic energy reports of countries other than the U. S. that are abstracted in *Nuclear Science Abstracts*.

**ALABAMA**
Auburn, Auburn University
Birmingham, Public Library
**ARIZONA**
Tucson, University of Arizona
**ARKANSAS**
Fayetteville, University of Arkansas
**CALIFORNIA**
Berkeley, University of California
Los Angeles, University of California
Menlo Park, Stanford Research Institute
San Diego, Public Library
**COLORADO**
Boulder, University of Colorado
Denver, Public Library
**CONNECTICUT**
New Haven, Yale University
**DELAWARE**
Newark, University of Delaware
**DISTRICT OF COLUMBIA**
Washington, Library of Congress
**FLORIDA**
Coral Gables, University of Miami
Gainesville, University of Florida
**GEORGIA**
Atlanta, Georgia Institute of Technology
**HAWAII**
Honolulu, University of Hawaii
**ILLINOIS**
Chicago, John Crerar Library
Chicago, University of Chicago
Evanston, Northwestern University
Urbana, University of Illinois
**INDIANA**
Indianapolis, Public Library
Lafayette, Purdue University
**IOWA**
Ames, Iowa State University
**KANSAS**
Manhattan, Kansas State University
**KENTUCKY**
Lexington, University of Kentucky
Louisville, University of Louisville
**LOUISIANA**
Baton Rouge, Louisiana State University
New Orleans, Tulane University

**MARYLAND**
Baltimore, Johns Hopkins University
College Park, University of Maryland
**MASSACHUSETTS**
Cambridge, Harvard University
Cambridge, Massachusetts Institute of Technology
**MICHIGAN**
Ann Arbor, University of Michigan
Detroit, Public Library
**MINNESOTA**
Minneapolis, University of Minnesota
**MISSOURI**
Kansas City, Linda Hall Library
Rolla, University of Missouri School of Mines and Metallurgy
St. Louis, Washington University
**MONTANA**
Bozeman, Montana State College
**NEVADA**
Reno, University of Nevada
**NEW JERSEY**
Princeton, Princeton University
**NEW MEXICO**
Albuquerque, University of New Mexico
**NEW YORK**
Buffalo, University of Buffalo
Ithaca, Cornell University
New York, Atomic Industrial Forum, Inc.
New York, Columbia University
New York, Public Library
Rochester, University of Rochester
Schenectady, Union College
Syracuse, Syracuse University
Troy, Rensselaer Polytechnic Institute
**NORTH CAROLINA**
Charlotte, Charlotte and Mecklenburg County Public Library
Durham, Duke University
Raleigh, North Carolina State College
**NORTH DAKOTA**
Grand Forks, University of North Dakota
**OHIO**
Cincinnati, University of Cincinnati
Cleveland, Public Library
Columbus, Ohio State University
Toledo, University of Toledo

**OHIO (CONT.)**
Youngstown, Youngstown University
**OKLAHOMA**
Stillwater, Oklahoma State University
**OREGON**
Corvallis, Oregon State College
Portland, Reed College
**PENNSYLVANIA**
Philadelphia, University of Pennsylvania
Pittsburgh, Carnegie Library
University Park, Pennsylvania State University
**PUERTO RICO**
Rio Piedras, University of Puerto Rico
**RHODE ISLAND**
Providence, Brown University
**SOUTH CAROLINA**
Columbia, University of South Carolina
**TENNESSEE**
Knoxville, University of Tennesse
Memphis, Public Library
Nashville, Joint University Libraries
Oak Ridge, Oak Ridge Institute of Nuclear Studies
**TEXAS**
Austin, University of Texas
College Station, Agricultural and Mechanical College of Texas
Dallas, Southern Methodist University
Houston, Rice Institute
San Antonio, Public Library
**UTAH**
Salt Lake City, University of Utah
**VIRGINIA**
Blacksburg, Virginia Polytechnic Institute
Charlottesville, University of Virginia
**WASHINGTON**
Pullman, Washington State University
Seattle, University of Washington
**WEST VIRGINIA**
Morgantown, West Virginia University
**WISCONSIN**
Madison, University of Wisconsin
Milwaukee, Public Library
**WYOMING**
Laramie, University of Wyoming

Volume 17, Number 4, February 28, 1963

# NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Division of Technical Information, Edward J. Brunenkant, Director.
Published by the USAEC Division of Technical Information Extension, Robert L. Shannon, Extension Manager.

NUCLEAR SCIENCE ABSTRACTS is the only comprehensive abstracting and indexing service devoted solely to the literature of nuclear science and technology. Published twice each month since 1947, NSA provides coverage of (1) technical reports of the United States Atomic Energy Commission and its contractors, (2) technical reports of government agencies, universities, and industrial and independent research organizations in the United States and abroad, and (3) the book, patent, and journal literature, on a world-wide basis.

MANAGING EDITOR
John W. Norris

ASSISTANT MANAGING EDITOR
Donald D. Davis

ASSOCIATE EDITOR
Robert C. Kelly

PRODUCTION EDITOR
Lawrence T. Whitehead

TECHNICAL EDITOR
David E. Bost

INDEX EDITOR
Everett J. Hoffman

EVALUATORS
William D. Matheny
John H. Mitchell
Mary H. Newman
Lee M. Thompson

SUBJECT AUTHORITY EDITOR
Thomas R. Henley

CORPORATE AUTHORITY EDITOR
Clara L. Fox

ABSTRACTORS
D. Lamar Cason
Henry H. Dix
James R. Dulaney
Bernard O. Griggs
Mary Catherine Grissom
Phyllis Hansen
Thomas F. Heagerty
Carolyn D. Houston
Rose V. Jermain
Julia Redford
Ned W. Rizzardi
Anne G. Ward

EXCHANGES
Margaret L. Pflueger

SCHEDULING AND
PUBLISHING COORDINATOR
Henry H. Lansford

Communication concerning the editorial policy and content of NSA should be addressed to the Managing Editor, NUCLEAR SCIENCE ABSTRACTS, AEC Division of Technical Information Extension, P.O. Box 62, Oak Ridge, Tennessee.

# ARRANGEMENT OF ABSTRACTS

Informative abstracts are arranged according to several categories and subcategories as illustrated by the Table of Contents. Author abstracts are frequently used. A single abstract is presented for a single report or article. In the case of comprehensive progress reports, or conference proceedings and symposia, an abstract is provided both for the whole publication and for each individual topic, section, or paper. The subject matter of the item abstracted determines the placement of an abstract into the category arrangement. In certain instances more than one category could be considered for an abstract. In such cases, the category which encompasses most of the subject matter of the item is selected, and "see" references are provided at other appropriate category headings.

# INDEXES TO NSA

**Regular Cumulations.** Each issue of NSA includes indexes for personal author, corporate author (issuing organization), subject, and report number. These indexes are cumulated quarterly as Numbers 6B and 18B, semiannually as Number 12B, and annually as Number 24B. The entries in the report number index cite, when known, the sources through which the report is made available and, if appropriate, the price. Report numbers also appear in the personal author, subject, and corporate author indexes. The personal and corporate author indexes include "short titles" of the items indexed. The subject index consists of main headings that are generally names of specific materials or objects followed by modifiers that describe the properties of, and processes applied to, the subject of the main headings. Cross references ("see" and "see also" references) appear in the cumulative indexes. Index entries are arranged according to the word-by-word alphabetic system.

**Multivolume Subject and Author Accumulations.** A cumulated author and subject index covering Volumes 1 through 4 (July 1948–1950) is included in the bound Volume 4 which is available from the Johnson Reprint Corporation, 111 Fifth Ave., New York, N. Y. ($30.00). A subject and author index covering Volumes 5 through 10 (1951–1956) is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. ($5.25).

A cumulated index covering Volumes 11–15 (1957–1961) is available from the U. S. Government Printing Office, Washington 25, D. C., as follows: Subject Index ($19.00), Personal Author Index ($14.25), and Corporate Author Index ($2.50).

**Cumulative Report Number Index.** A report number index is issued annually that includes all reports contained in all volumes of NSA together with public availability citations. The Cumulative Report Number Index, Vols. 1–16, will be available from the U. S. Government Printing Office, Washington 25, D. C., ($4.50).

# AVAILABILITY OF PUBLICATIONS ABSTRACTED

Public availability of all U. S. Atomic Energy Commission reports is indicated in the Report Number Index. Also included, when known, is the availability of many reports of other government agencies and organizations, both in the United States and abroad.

The availability of certain unnumbered reports abstracted in NSA is included in the abstract. The abbreviation GPO indicates that the material is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Journal articles, books, and other published materials are available through standard commercial subscriptions or library sources.

Dissertations taken from DISSERTATION ABSTRACTS are available from University Microfilms, Inc., 315 N. First Street, Ann Arbor, Michigan.

Many of the published materials abstracted in NSA are deposited in the Library of the Oak Ridge Institute of Nuclear Studies (a USAEC Depository Library) and are available on interlibrary loan from that source.

# TABLE OF CONTENTS

Volume 17, Number 4, February 28, 1963

*Category* *Page*

GENERAL AND MISCELLANEOUS . . 559
BIOLOGY AND MEDICINE . . . . 561
- General and Miscellaneous . . . 561
- Biochemistry, Nutrition, and Toxicology . . . . . . 562
- Fallout and Ecology . . . . . 563
- Radiation Effects on Living Tissues . . . . . . . 563
- Radiation Sickness . . . . . 569

CHEMISTRY . . . . . . . 571
- General and Miscellaneous . . . 571
- Analytical Procedures . . . . . 572
- Inorganic and Physical Chemistry. . . . . . . 576
- Organic Chemistry . . . . . 585
- Radiation Chemistry and Radiochemistry. . . . . . 586
- Raw Materials and Feed Materials . . . . . . . 593
- Separation Processes . . . . . 594

ENGINEERING AND EQUIPMENT . . 596
- General and Miscellaneous . . . 596
- Heat Transfer and Fluid Flow . . 598
- Materials Testing. . . . . . 601

GEOLOGY, MINERALOGY, AND METEOROLOGY . . . . . 602

HEALTH AND SAFETY . . . . . 608

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS . . 610

INSTRUMENTS AND INSTRUMENTATION 612
- General and Miscellaneous . . . 612
- Radiation Detection . . . . . 615

ISOTOPE SEPARATION . . . . . 625

MATHEMATICS AND COMPUTERS . . 627

METALS, CERAMICS, AND OTHER MATERIALS . . . . . . 628
- General and Miscellaneous . . . 628
- Corrosion . . . . . . . . 630
- Fabrication . . . . . . . . 631
- Properties and Structure . . . 632
- Radiation Effects . . . . . . 641

PHYSICS . . . . . . . . . 647
- General and Miscellaneous . . . 647
- Astrophysics and Cosmology . . 664
- Cosmic Radiation . . . . . . 666
- Criticality Studies . . . . . 669
- Elementary Particles and Radiations . . . . . . 669
- Neutron Physics . . . . . . 680
- Nuclear Properties and Reactions . . . . . . 683
- Particle Accelerators . . . . . 693
- Plasma Physics and Thermonuclear Processes. . . 694
- Shielding . . . . . . . . 706
- Theoretical Physics . . . . . 707

REACTOR TECHNOLOGY . . . . 712
- General and Miscellaneous . . . 712
- Power Reactors . . . . . . 715
- Research Reactors . . . . . 717

SPACE APPLICATIONS AND TECHNOLOGY. . . . . . 719

WASTE DISPOSAL AND PROCESSING . . . . . . 721

CORPORATE AUTHOR INDEX . . INDEX-1

PERSONAL AUTHOR INDEX . . INDEX-6

SUBJECT INDEX . . . . . INDEX-28

REPORT NUMBER INDEX . . . INDEX-70

# HOW TO OBTAIN NUCLEAR SCIENCE ABSTRACTS

**Subscription.** The semimonthly abstract issues and the four cumulated-index issues are available postpaid on subscription and in single copy from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at the prices indicated below:

- SEMIMONTHLY ISSUES. Annual subscription rate: $22.00, domestic; $27.50, foreign. Price per single copy: $1.25, domestic; 25 per cent extra for foreign mailing.
- CUMULATIVE-INDEX ISSUES. Annual Subscription rate: $22.00, domestic; $25.00, foreign. Price per single copy varies according to the number of pages. The Cumulative Report Number Index, Vols. 1–17, will also be available separately from the Superintendent of Documents, U. S. Government Printing Office, at a price to be announced later.
- DOMESTIC SUBSCRIPTION RATES apply to the United States, Canada, Mexico, and all Central and South American countries, except as noted below.
- FOREIGN SUBSCRIPTION RATES apply to Argentina, Brazil, British and French Guiana, Surinam, British Honduras, and all other countries throughout the world.

**Exchange.** NSA is also available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Inquiries should be directed to the Division of Technical Information Extension, U. S. Atomic Energy Commission, P. O. Box 62, Oak Ridge, Tennessee.

**Availability to Government Agencies.** NSA is available free of charge to U. S. Government Agencies upon request to the Division of Technical Information Extension, U. S. Atomic Energy Commission, P. O. Box 62, Oak Ridge, Tennessee.

# NOTE ON TRANSLATIONS

The literature of nuclear science and technology is abstracted and indexed in NUCLEAR SCIENCE ABSTRACTS where possible from the original language. Abstracts of translations appear in NSA only when the original material was not available. For translations of the original language material appearing in NSA into other languages, including English, such sources as: (1) "USAEC Translation Lists" and TID-4025 "Translation Title List and Cross Reference Guide" published by the Division of Technical Information, U. S. Atomic Energy Commission and (2) TECHNICAL TRANSLATIONS published by the Office of Technical Services, U. S. Department of Commerce should be consulted. Source (1) is available at all AEC domestic and foreign depositories. Source (2) is available on subscription from the Superintendent of Documents, U. S. Government Printing Office, annual subscription $12.00 ($4.00 additional for foreign mailing).

### Legal Notice

The AEC reports listed in this document are accounts of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in these reports, or that the use of any information, apparatus, method, or process disclosed in these reports may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in these reports.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

---

*Use of funds for printing this publication has been approved by the Bureau of the Budget, July 29, 1960.*

Volume 17, Number 4 February 28, 1963

# NUCLEAR SCIENCE ABSTRACTS

## GENERAL AND MISCELLANEOUS

**4374** (MLM-1129) MOUND LABORATORY MONTHLY PROGRESS REPORT FOR JANUARY 1962. J. F. Eichelberger (Mound Lab., Miamisburg, Ohio). Jan. 31, 1962. Contract AT-33-1-GEN-53. 37p.

Flow curves were run on plastics with applied force of 2.5 to 15 tons. Thirteen adhesive formulations, cast into films, are being evaluated for tensile strength and elongation. Several epoxy-modified Adiprene-polyol systems catalyzed with ferric acetonate were evaluated for possible use as adhesives which cure rapidly at room temperature. The equipment for xenon purification and isotope separation by low-temperature distillation was improved. A computer program that was devised for an ideal cascade of gas centrifuges for uranium isotope separation was revised to include the effects of variable enrichment, flow rates, and total feed. Studies are being made to discover the cause of slow variations in the measured power output of radioactive samples. Techniques for vapor deposition of beryllium on plastic microfilms were investigated. The adsorption of trace radioelements evaporated to dryness on metal and glass surfaces is being studied. The half life of $Ra^{223}$ is being redetermined by microcalorimetry and alpha counting. Methods are being developed to determine the coincidence correction in proportional counters by following the decay of pure radioisotopes. Ways of determining traces of $Ac^{227}$ in $Ra^{223}$ are being investigated. Studies are being made of the physical properties of plutonium-bearing materials. Phase studies were made of the Ce-Pu system by differential thermal analysis and metallographic studies. Rods of various diameters were fabricated from plutonium oxide and uranium oxide glasses. Lead-loaded Neoprene rubber gloves were tested to determine the general characteristics of the material. (M.C.G.)

**4375** (MLM-1133) MOUND LABORATORY MONTHLY PROGRESS REPORT FOR FEBRUARY 1962. J. F. Eichelberger (Mound Lab., Miamisburg, Ohio). Feb. 28, 1962. Contract AT-33-1-GEN-53. 33p.

Flow curves were determined for four plastics. Composition and curing characteristics of room-temperature-cured adhesives were determined. Flowmeters used in the gas chromatographic system were calibrated. The decomposition of CO by a hot wire was studied. The feasibility of recovering $U^{234}$ from aged $Pu^{238}$ materials was demonstrated, and a separation and purification scheme is proposed. Methods of beryllium vapor deposition of plastic films are being developed. The half life of $Ra^{223}$ is being redetermined by microcalorimetry and alpha counting. A sample of partially purified protactinium was analyzed. The specific heat determination of Pu metal is in progress. Viscosity determinations are being made for Ce. Phase studies are being made on Ce-Pu alloys. Techniques are being developed for spheroidization of glass particles of less than 20 $\mu$. (M.C.G.)

**4376** (TID-14912) STATE OF NUCLEAR TECHNOLOGY—JANUARY 1962. A. Crewe, S. Lawreski, and B. I. Spinrad (Argonne National Lab., Ill.). Nov. 1961. Contract [W-31-109-eng-38]. 4p. (UAC-5792)

Events in nuclear technology in 1961 are reviewed. The SL-1 incident, operation of the Yankee plant, restarting of the Dresden plant, contributions to the state of water reactor technology, transitions to private industry, dry criticality in EBR-II, startup of Los Alamos Molten Plutonium Reactor Experiment (LAMPRE), successful Tory tests, performance of SNAP reactor tests, and use of radioisotope-powered electric source in Transit IV A are discussed. (M.C.G.)

**4377** THE IMPORTANCE OF ATOMIC ENERGY IN TENNESSEE'S INDUSTRIAL DEVELOPMENT. James A. Lane (Oak Ridge National Lab., Tenn.). J. Tenn. Acad. Sci., 37: 88-92(July 1962).

It is shown that many other states are in an analogous situation to that of Tennessee, in that many secondary benefits will accrue from the development of peaceful uses of the atom, but nuclear power, as such, will not contribute directly to their economic growth. In Tennessee, conventional power costs are about 0.5 mill less than the lowest projected nuclear power costs. However, the Oak Ridge complex of research and development facilities is described as a potential area of growth. (R.J.S.)

**4378** THE INTERNAL CONSTITUTION OF THE MOON. Zdeněk Kopal (Univ. of Manchester, Eng.). Planetary Space Sci., 9: 625-38(Oct. 1962).

A survey of the present knowledge bearing on the internal structure of the Moon leads to the following conclusions: The relatively low mean density of the lunar globe suggests that the Moon is approximately of the same composition as the terrestrial mantle (or the non-volatile fraction of the solar atmosphere), but is either deficient in iron (about 11 to 14 per cent by weight, as against 28 per cent for the Earth), or enriched with some common low-density substance (such as $H_2O$ or $C_2$). The mass of the Moon is in a state very close to hydrostatic equilibrium, but deviations from it (as inferred from the motion of the Moon) are significant. In particular, the observed libration of the Moon is definitely inconsistent with an assumption that its form is one of equilibrium under forces prevailing at any distance from the Earth. The crust of the Moon cannot sustain large-scale differences in level of more than 1 km; and the apparent absence of free physical libration reveals that the degree of rigidity of the lunar globe must be considerably less than the Earth. Radiogenic heat produced by a spontaneous decay of such long-lived radioactive elements as $K^{40}$, $Th^{232}$ or $U^{235}$, and $U^{238}$ should have raised the present temperature of the bulk of the lunar mass to at least 1000°K (and to 1500 to 2000°K at the center) even if the Moon originated as an initially cold body. Moreover, these temperatures should at present still be increasing (though they are not very far from their maximum to be attained some 2000 to 3000 million years in the future). The conductive temperature gradient created by radiogenic heating exceeds the adiabatic gradient of molten rocks by a factor of 10 to 100 in the greater part of the interior, rendering it almost certain that slow convection currents (with velocities generally less than 1 cm/year) will provide at least as effective a means of outward heat transport as conduction or radiation. Theoretical considerations indicate, moreover, that stable convection flow can develop only for patterns characterized by spherical-harmonic symmetry of very high order. This flow is probably the main cause for the distribution of mass inside the Moon deviating from hydrostatic equilibrium, as evidenced by the motion of the Moon. The observed disparity in distribution of the lunar maria between the near and far side of the Moon is also likely to be due to this cause. Should the newly-formed Moon have contained a sufficient proportion of such short-lived radioactive elements as $I^{129}$, $Pd^{107}$ or $Al^{26}$ to melt it completely in the first 10 million years of its existence, convective cooling would have been capable of bringing about solidification in a comparable period of time. The secular heating should, moreover, have been accompanied by a gradual escape of volatile elements or compounds from the interior; and observable surface manifestations of such processes are briefly discussed. (auth)

**4379** PROCEEDINGS OF INTERNATIONAL CONFERENCE ON IONIZATION OF THE AIR, FRANKLIN INSTITUTE, PHILADELPHIA, PENNA., OCTOBER 16-17, 1961. VOLUME I, SECTIONS I TO XII. VOLUME II, SECTIONS XIII TO XXVII. Philadelphia, American Institute of Medical Climatology, [1962]. 436p.

Twenty-seven papers are presented on various aspects of air ionization. The aspects include the nature of air ions, measurement methods, physics of air ions, biological effects, and human reactions to ionized air. (D.L.C.)

# BIOLOGY AND MEDICINE

## General and Miscellaneous

**4380** (UCRL-10479) BIO-ORGANIC CHEMISTRY QUARTERLY REPORT, JUNE THROUGH AUGUST 1962. R. B. Park and Kenneth Sauer, eds. (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 26, 1962. Contract W-7405-eng-48. 55p.

Research progress is reported on: the synthesis of compounds from $C^{14}O_2$ by Chlorella in the dark following preillumination; the effect of oxygen on the formation of glycolic acid and other products during photosynthesis by Chlorella; phosphatase action on phosphoglycolic, 3-phosphoglyceric, and phosphoenolpyruvic acids in spinach chloroplast fragments in the presence and absence of high concentrations of methanol; absorption spectra of scattering samples, evaluation of three different spectrophotometric techniques using Chlorella and scattered transmission spectra of spinach; the effect of sonication of spinach chloroplasts on photosynthetic phosphorylation; the occurrence of $\alpha,\alpha$-tocopherol and $\alpha$-tocopherylquinone in chloroplasts and quantasomes; the effects of ultraviolet and gamma radiation on thymine in frozen aqueous solution and in the solid state; and a rapid method for the identification of small quantities of lipid-soluble vitamins and quinones in biological materials. (auth)

**4381** SOME PROBLEMS IN THE ANALYSIS OF MULTI-FACTOR TABLES. William J. Schull (ABCC, Nagasaki). Bull. Inst. Intern. Statist., 38: 259-70(1961).

The genetic effects of radiation on the population of Hiroshima and Nagasaki are analyzed in terms of the abnormalities of children born to parents, one or both of whom were exposed to the radiation from the atomic bombing of these cities. The abnormalities under consideration are those arising within the first nine months of life. The only genetic factor found to be definitely affected by the irradiation is the sex ratio. The statistical analysis of the data obtained is described. The statistical analysis of categorical data that are multiply classified is also discussed. (T.F.H.)

**4382** ON RENAL ANGIOGRAPHY WITH THORIUM DIOXIDE: AN EXPERIMENTAL STUDY IN DOGS. N. P. G. Edling and C. O. Ovenfors (Karolinska Sjukhuset, Stockholm). Radiology, 79: 1015-16(Dec. 1962).

Thorium dioxide was used experimentally in a series of renal arteriographies in dogs. A true angiogram was obtained by which arteries and veins may be studied. The results of the study were in good agreement with studies made previously by others. (P.C.H.)

**4383** THE EXTERNAL BETA-ISOTOPE CONTACT THERAPY: TECHNIQUES AND DOSIMETRY. Giorgio Scarpa and Francesco Pigorini (Università, Rome). Ric. Sci., Rend., 2: 127-55(July 1962). (In Italian)

A survey was made of the principal techniques for carrying out external beta contact therapy, starting from those based on the use of radium or other natural radionuclides to more modern techniques using pure beta-emitting radioisotopes, such as $Y^{90}$ and $P^{32}$. The dosimetry of beta-plane sources to be used in contact with the lesion is discussed. The main difficulty of the dosimetry lies in the very strong dose gradient at the surface of the source which is due to geometric reasons as well as to the short range of the beta particles. The dosimetric methods are distinguished in mathematical and direct and indirect instrumental methods, in practice carried out by means of extrapolation chambers, flat ionization chambers with small windows, photographic films with finest emulsion, common NaI crystal sparkers, and common thimble-shaped cylindric ionization chambers. The mathematical methods, based on pure calculation, are applicable only in particular cases, because of the difficult conditions required to put them into practice. Other methods mentioned have a vast range of application, but if the chambers of extrapolation are excluded, all the methods depend on the use of a sample source for the calibration of the diapositive; in case of photographic dosimetry the source, besides $\beta$, could as well be x or $\gamma$. The technique of equipping the $P^{32}$ applicator in blotting paper filtered with 20 mg/cm$^2$ pure rubber and screened with 800 mg/cm$^2$ lead-treated rubber is described in detail. The blotting paper used was that for Munktell No. 20 chromatography, with a surface density of 16 mg/cm$^2$. The most delicate phase of the technique is the imbibition of the border of the blotting paper, which may be effected by dripping or else by immerging one side. Experiments were also carried out with polythene leaves impregnated with $P^{32}$. The advantages of the method, such as easy use, minimum danger of contamination, and highest surface doses, are emphasized. (auth)

**4384** ISOLATION OF A RADIO-RESISTANT MUTANT OF STAPHYLOCOCCUS AUREUS. Roberto Masironi and Alberto Mancinelli (Università, Rome). Ric. Sci., Rend., 2: 173-6(July 1962). (In Italian)

A method of obtaining a strain of S. aureus resistant to tritium-emitted beta radiations and x rays is described. The use of tritiated water proved to be a very useful means of easily obtaining mutant strains. The biophotometric technique employed was a very practical one for rapidly following the development of the treated germs. (auth)

**4385** SURVIVAL RATE OF BLADDER TUMORS AFTER CONVENTIONAL AND MEGAVOLTAGE RADIATION THERAPY. Werner Hellriegel, Joachim Scharz, and J. Lott (Universitäts-Röntgeninstitut, Frankfurt am Main). Strahlentherapie, 119: 177-86(Oct. 1962). (In German)

In comparing conventional and megavoltage irradiation of bladder carcinoma, it can be shown statistically that megavoltage therapy increases the 3 year survival rate. It is about 60% with megavoltage therapy and 27% with conventional therapy. The survival rates are especially favorable, if only minor surgery was done before irradiation and if the patient is irradiated as early as possible after diagnosis. Under these conditions the 3-year survival rate may be up to 75%. The results become unfavorable if spread has occurred. The tendency to recurrences after irradiation is great, if earlier recurrences were treated by surgery. Removal of the tumor down to the mucosa level is recommended, because in those cases the healing after irradiation occurs without complications. No effect on bowel function was noted. (auth)

**4386** APPLICATIONS OF IODINE-132 IN STUDIES OF THYROID PHYSIOLOGY. M. Anbar (Weizmann Inst. of Science, Rehovoth, Israel and IAEA Research Labs., Rehovoth, Israel). IAEA Preprint SM-32/42. 13p. (In English)

To be published in Proceedings of the IAEA Seminar on the Practical Applications of Short-Lived Radioisotopes Produced in Small Research Reactors, Vienna, November 5-9, 1962.

$I^{132}$ was applied to two different problems in thyroid physiology. (1) Determination of radiation damage to the thyroid at relatively low doses of internal radiation. It has been found that the rate of production of protein bound iodine (PBI) by the thyroid significantly increases 24 hours after the thyroid absorbed doses of internal radiation in the range 50 to 100 rads. These findings were made possible by using $I^{131}$ as the source of internal radiation and $I^{132}$ as an indicator of the rate of production of PBI. Next, $I^{132}$ was used as a source of internal radiation as well as a tracer for PBI production, because it was possible to determine the effects of radiation without interference of the radiological dose. These experiments, which were carried out on rats, are presently being extended to human patients to determine the possible radiation damage of tracer doses of $I^{131}$. During this investigation, special techniques were developed to cope with the specific requirements of using $I^{132}$ in thyroid studies. (2) A quantitative determination of the rate of thyroxine deiodination in humans. In the course of an extensive investigation of factors which affect the rate of deiodination of thyroxine in mice and rats it became of interest to determine this process in humans. The change in concentration of labeled thyroxine with time reflects the composite disappearance of thyroxine including clearance via liver and re-absorption from intestines. In any procedure chosen, the inorganic iodide liberated from the labeled thyroxine has to be assayed. Consequently, the fate of iodide in the system determines the method of investigation. In humans the relative rates of deiodination and iodide clearance are about 1:70 and thus a steady state concentration of iodide in serum is attained. (auth)

**4387** BROMINE-82 LABELLING OF HUMAN SERUM ALBUMIN, FIBRINOGEN AND INSULIN BY ELECTROCHEMICAL MEANS. U. Rosa, G. A. Scassellati, and G. Pennisi (SORIN, Saluggia, Italy). IAEA Preprint SM-32/50. 19p. (In French)

To be published in Proceedings of the IAEA Seminar on the Practical Applications of Short-Lived Radioisotopes Produced in Small Research Reactors, Vienna, November 5-9, 1962.

A method using $Br^{82}$ to label human serum albumin, fibrinogen, and insulin is described. The method involves electrolytic bromination in an aqueous solution; this is performed in an electrolytic cell, whose anodic zone containing the substance to be labeled is partitioned from the cathodic zone by a dialysis membrane. For each of the three substances mentioned, the degree of bromination produced by a direct current (100, 200, 300 $\times 10^{-6}$ A) was studied as a function of anode potential in $10^{-3}$ and $10^{-4}$ M solutions of $NH_4Br$, the amount of bromine-labeled substance formed being checked by radioelectrophoresis for various anodic potential values differing from each other by 50 mv. By immuno-electrophoresis it was ascertained that denaturation of albumin and fibrinogen only starts at anodic potential values for which the degree of labeling is already very high as compared with that yielded by chemical methods of labeling. The method described has the advantage of rapid execution and is well suited to remote handling in a shielded zone. (auth)

## Biochemistry, Nutrition, and Toxicology

**4388** TOXICOLOGY: INORGANIC. Harry Foreman (Los Alamos Scientific Lab., N. Mex.). Ann. Rev. Pharmacol., 2: 341-62(1962). (TID-13972; LADC-5073)

A review is presented on the toxicologic studies conducted in the last 3 years up to July 1961. The poisons treated include air-borne poisons (dusts, silica, pollutants, ozone, nitrogen oxides, sulfur oxides, and carbon monoxide) and metal poisons (As, B, Cd, Cr, Fe, Pb, Hg, Ni, and Se). (D.L.C.)

**4389** THERMAL DENATURATION OF ORDINARY AND FULLY DEUTERIATED DNA IN $H_2O$ AND $D_2O$. H. L. Crespi and J. J. Katz (Argonne National Lab., Ill.). J. Mol. Biol., 4: 65-8(1962). (TID-14067)

Fully deuteriated DNA was isolated from Escherichia coli grown in a fully deuteriated nutrient medium (99.6% $D_2O$ with fully deuteriated substrates). The melting temperature of this DNA was found to be essentially identical with that of ordinary DNA in both $H_2O$ and $D_2O$ solutions. (auth)

**4390** THE PATH OF CARBON IN PHOTOSYNTHESIS. J. A. Bassham (Univ. of California, Berkeley). Sci. Am., 206: 3-14(June 1962). (UCRL-9583; UCRL-10104)

The background on photosynthesis chemistry is discussed, and the research on photosynthesis is described. The work of Melvin Calvin on algae beginning in 1946 is discussed in detail along with the experimental procedures involved. It was found that the $C^{14}$ from $CO_2$ was rapidly distributed among sugars, amino acids, and other organic compounds in algae, and two-dimensional paper chromatography was used to determine the pathway intermediates. Studies of the effects of sudden darkness and $CO_2$ depletion on the intermediates are also described. The probable oxidation and reduction cycles in photosynthesis are outlined. A study of the flow of C in photosynthesis was conducted which shows that all the stable intermediates of the cycle are saturated with $C^{14}$, that the cycle accounts for >70% of the total C fixed by the algae, and that fats and amino acids are true products of photosynthesis. (D.L.C.)

**4391** THE PHYSIOLOGICAL AND PHARMACOLOGICAL BEHAVIOR OF CESIUM-137 IN RELATION TO THAT OF POTASSIUM AND SODIUM. Bhamidipaty Venkata Rama Sastry. Thesis, Nashville, Vanderbilt Univ., 1962. 106p.

A study was undertaken to determine by means of in vivo experiments the excretion and distribution patterns of $Cs^{137}$ in the rat and to modify the patterns by drugs (desoxycorticosterone, cortisone, aminophylline, chlorothiazide, and acetazolamide), which were known to affect the mineral metabolism in the animal body. According to the study, the biological half-time for the excretion of $Cs^{137}$ in the rat after intraperitoneal administration was about 8 days. About 5-6 times more $Cs^{137}$ was excreted in the urine than in the feces. Analysis of the tissues at the end of the eighth day revealed that intracellular concentration of $Cs^{137}$ was higher than that in blood. The organs can be arranged in the following order according to the concentrations of $Cs^{137}$ found in them: gastrocnemius muscle > ileum > kidney > stomach > liver > heart > spleen > lung > brain. While cortisone, and aminophylline did not modify the excretory and distribution patterns of $Cs^{137}$, acetazolamide and its analogs influenced the parameters significantly. Desoxycorticosterone increased the concentration of $Cs^{137}$ in the gastrocnemius muscle. The carbonic anhydrase inhibitors, acetazolamide, Ethoxzolamide and Dichlorphenamide (each, 10 mg/kg, I.P.) increased $Cs^{137}$ excretion and raised the pH of urine during their drug phase of 6 hours. Meralluride (6.8 mg of Hg/Kg, S.C.) blocked the effect of acetazolamide on $Cs^{137}$ excretion, and ammonium chloride increased $Cs^{137}$ excretion. There was no significant difference between the $Cs^{137}$ excretion by the animals treated with ammonium chloride, and the $Cs^{137}$ excretion by the animals treated with ammonium chloride followed by acetazolamide. Maleate increased the $Cs^{137}$ excretion and raised the pH of urine. The observations indicated that acetazolamide increased $Cs^{137}$ excretion by inhibiting renal carbonic anhydrase and by increasing its secretion in the renal tubules. The results of long term experiments (10 mg/kg/24 hours, 8 days) indicated that acetazolamide does not affect $Cs^{137}$ excretion after cesium is deposited in the tissues, and low concentrations of $Cs^{137}$ found at the end of the eighth day in the gastrocnemius muscles of the treated rats are due to the increased excretion of $Cs^{137}$ after the first injection of acetazolamide. Chlorothiazide, in a dose of 500 mg/kg increased $Cs^{137}$ excretion, urine volume, and pH of urine during the first hour. Chlorothiazide decreased $Cs^{137}$ excretion during the period 6-24 hours and also the cumulative $Cs^{137}$ excretion during 0-24 hours after a single dose (500 mg/kg, I.P.) and therefore the treated animals showed a tendency to retain more $Cs^{137}$ than the control animals. In the long term experiment, in a dose of 50 mg/kg/day, chlorothiazide did not influence $Cs^{137}$ excretion. Higher concentrations of $Cs^{137}$ were found in the gastrocnemius muscles of the treated rats than the concentrations of $Cs^{137}$ in those of the control rats. (Dissertation Abstr., 23: No. 4, 1962)

## Fallout and Ecology

**4392** CONTAMINATION OF GRASS BY $^{90}$Sr IN POLAND. Aleksy Jagielski, Andrzej Stanoch, Adolf Zajac, and Janina Zurawska (Inst. of Agriculture, Krakow). Nukleonika, 7: 357-9(1962). (In Polish)

Samples of grass were gathered from six regions of the Krakow district in June, 1961, and analyzed for $Sr^{90}$ content. Two samples were obtained from each area, and the analysis for $Sr^{90}$ was carried out separately on each of the two samples to indicate the reproducibility of the measured specific activation. The grass, in each case, was in the same stage of blooming or maturity. Analysis of the $Sr^{90}$ content was carried out by a variation of the Chicago Sunshine Method that is described in detail. Within the six areas, the contamination tended to increase with increase of altitude of the locale from which the sample was obtained. The contamination level was of the same order as that presented elsewhere in the literature (Kernenergie). (TTT)

## Radiation Effects on Living Tissues

**4393** INFLUENCE OF X-RAY IRRADIATION OF THE CENTRAL NERVOUS SYSTEM OF ALBINO RATS ON THE GLYCOGEN CONTENT IN THE LIVER CELLS. Irena Krolikowska-Prasał and Jerzy Szydłowski. Ann. Univ. Mariae Curie-Skłodowska, Lublin-Polonia, Sect. D, 16: 93-107(1961). (In Polish)

Results are reported from an investigation of the effects of head irradiation on the glycogen content in the liver cells of albino rats. The material consisted of 75 experimental animals and 10 control rats. The former received on their heads doses of 600 r, 1200 r, and twice 600 r at 24 hour intervals. The animals were killed immediately or after 2 hours, 24 hours, 7 days, and 21 days. The material thus obtained was studied by the histochemical method of Best and by the photometric anthrone method. The results, which were analyzed statistically, led to the conclusion that the liver tissue, which is resistant to the local action of ionizing radiation, presents metabolic and enzymatic changes, which can be detected by histochemical and chemical methods. A decrease of the glycogen content, which is observed during the first hours after irradiation of the central nervous system, is probably a result of the loss of appetite and of digestive disturbances, entering into the complex of a mild general irradiation reaction. The rise of the curve values is the result of the action of the compensatory system, pituitary gland and adrenals, reacting to the stimuli of fasting and irradiation. The considerable fall in the curve after 600 and 1200 r may be due to a limited uptake of food; the less pronounced fall and greater rise in the curve values in the later period can be ascribed to the formation of a strong stimulus compensating the glycogen level when the difference in the intensity of the general irradiation reaction is comparatively small. (auth)

**4394** COMPARATIVE RESISTANCE OF STRAINS OF CLOSTRIDIUM BOTULINUM TO GAMMA RAYS. A. Anellis (U. S. Army Quartermaster Food and Container Inst., Chicago) and Robert B. Koch. Appl. Microbiol., 10: 326-30 (July 1962).

A total of 102 strains of Clostridium botulinum (56 strains of type A, 43 type B, and 3 non-toxigenic strains which could not be typed) was examined for resistance to gamma rays. When the organisms were suspended in neutral phosphate buffer in concentrations of $10^4$ spores per tube, the threshold sterilizing dose appeared to be 1.4 Mrad. Partial survival to 1.4 Mrad was shown by 10.7% of the type A strains, 18.6% of the type B strains, and 1 of 3 nontoxigenic strains. Overall, type A strains indicated higher radioresistance than type B strains, although there was overlapping. Representatives of the most resistant strains had D values of 0.317 to 0.336 Mrad; the D values of an intermediate group were 0.224 to 0.253 Mrad, and the most sensitive strain studied, 51B, had a D value of 0.129 Mrad. The radioresistance of Putrefactive Anaerobe 3679, strain S-2, was comparable to the intermediate C. botulinum group (D = 0.209). (Public Health Eng. Abstr., 42: No. 11, Nov. 1962)

**4395** OCCUPATIONAL EXPOSURE TO IONIZING RADIATION. Henry F. Howe (American Medical Association, Chicago). Arch. Environ. Health, 5: 626-30(Dec. 1962).

When investigating a case of delayed illness or injury possibly caused by occupational exposure to radiation, physicians with experience in the field of ionizing radiation injury should correlate all available exposure information with clinical evidence of possible radiation injury. They should consider all of the factors outlined in establishing a diagnosis of injury due to exposure to radiation in industry. After a thorough investigation of all the facts, physicians with experience in the field of ionizing radiation are best qualified to render an opinion concerning the existence and degree of impairment and whether the probability is greater or less than 50% that the impairment is the result of exposure to ionizing radiation at work. (R.J.S.)

**4396** EFFECTS OF HYDROCORTISONE AND X RADIATION ON SPONTANEOUS LEUKEMOGENESIS OF AkR MICE. J. F. Duplan (Institut du Radium, Paris). Compt. Rend. Soc. Biol., 156: 779-82(Sept. 20, 1962). (In French)

By exposing young AkR mice to a series of hydrocortisone injections, the delay in appearance of spontaneous lymphoid leukosis is increased. This increase of the latency is not found in whole-body irradiated AkR mice to which bone marrow cells from donors treated with cortisone were grafted. It is thus shown that the cortisone modifies leukemogenesis by an indirect mechanism and not by causing a definitive modification of lymphoid cells with a tendency to cancerous cells. (tr-auth)

**4397** EFFECT OF RADIATION ON THE INCORPORATION OF $C^{14}$-FORMATE INTO RNA PURINES IN CALF THYROID SLICES IN VITRO. R. Hall and R. J. Grand (Harvard Medical School, Boston and Massachusetts General Hospital, Boston). Endocrinology, 71: 914-19(Dec. 1962).

The effects of external gamma radiation on the incorporation of C$^{14}$-formate into acid-soluble and RNA purines and protein in calf thyroid slices *in vitro* were studied. Formate incorporation into protein was reduced to 50% by 50000 rads. Incorporation of formate into purines was much more radiosensitive, a reduction of 50% being obtained with 3500 rads. Evidence is presented that this represents, at least in part, a true inhibition of purine synthesis. It is postulated that such a mechanism might be responsible for the effect of therapeutic radiation on the thyroid. (auth)

**4398** EARLY HISTOPATHOLOGICAL AND HAEMATOLOGICAL EFFECTS OF SINGLE WHOLE-BODY X-IRRADIATION ON THE HAEMOPOIETIC SYSTEM OF MICE, RATS AND GUINEA-PIGS. Y. Honda (Hiroshima Univ.). Hiroshima Igaku, 8: 3999(1960).

Single whole-body x irradiation of 350 r was given to ddN strain mice of 5 weeks of age and to young rats; 200 to 180 r was given to young guinea pigs. In the irradiated mice a slight leukocytosis was seen 1 to 3 hours after the irradiation followed by a moderate leukopenia. The leukocyte counts were minimal on the 2nd day, then gradually recovered. The damage to the bone marrow was greatest on the 3rd day, which corresponded with the loss in weight of the spleen. On the 20th day, in irradiated rats, some increase in the leukocyte count and in the weight of the spleen and incomplete recovery of the bone marrow were recognized. The compensatory hemopoietic function of the spleen was affected most strikingly in mice, less so in rats and guinea pigs, in that order. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4399** LEUKAEMIA IN ATOMIC BOMB SURVIVORS IN HIROSHIMA. R. Heyssel, et al. Hiroshima Igaku, 14: No. 1, 141-84(1961).

A linear relationship was found between radioinduced leukemia and the radiation dose. Males and young subjects seemed in general to be more radio-sensitive than others. The minimum latent period after an explosion may be 3 years or less. The most frequent latent period was from 4 to 8 years in this series, which may have been influenced by the radiation dose received. The time taken for the leukemia to develop is not known. In the atomic bomb survivors there was an increase in chronic myeloid leukemia in the main. No radiation effect was found on the incidence of monocytic or chronic lymphatic leukemia. Other blood diseases such as asplastic anemia or polycythemia vera were also surveyed but, with the exception of myelosclerosis, no special relationship between their incidence and the irradiation was detected. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4400** RADIATION INJURIES IN CHILDREN ASSOCIATED WITH TREATMENT OF MALIGNANT AND BENIGN TUMORS. K. A. Moskacheva, T. D. Mirimova, L. A. Shparo, L. I. Nebolsina, and Yu. I. Barashnev (Inst. of Pediatrics, Academy of Medical Sciences, USSR). Med. Radiol., 7: No. 7, 38-45(July 1962). (In Russian)

The results of catamnestic observations on children who had undergone x-ray therapy for benign and malignant neoplasms in early childhood are discussed. Considerable radiation injuries of healthy bones, muscles, and skin, which were within the irradiation zone, were revealed. The changes became manifest many years after the irradiation. (auth)

**4401** THE INFLUENCE OF IONIZING RADIATION ON THE COURSE OF INFECTION AND THE STATE OF IMMUNITY IN MONKEYS WITH EXPERIMENTALLY INDUCED MEASLES. B. A. Lapin and Z. K. Stasilevich (Inst. of Experimental Pathology and Therapy, Academy of Medical Science, USSR). Med. Radiol., 7: No. 7, 62-7(July 1962). (In Russian)

The influence of sublethal doses of x radiation on the course of measles and the formation of immunity was studied. Experiments were staged on 12 monkeys. The results show that during x irradiation in a dose of 300 r and infection of the animals with the measles virus a reciprocal aggravation of the radiation and infectious processes occurs. As a result there is a sharp reduction of the resistance of the monkey's organism with attending complications, which lead to a lethal outcome in nearly half of the cases. Experiments with irradiation and infection with measles of immune animals disclosed that the antimeasles immunity evolved earlier proved to be so stable that even irradiation does not weaken it. (auth)

**4402** THE INFLUENCE OF SPECIFIC HEMOLYSINS ON THE PHAGOCYTOSIS DYNAMICS IN THE PERITONEAL EXUDATE DURING RADIATION SICKNESS. M. S. Kostenko. Med. Radiol., 7: No. 7, 90-2(July 1962). (In Russian)

Phagocytosis of peritoneal exudate leukocytes was studied *in vivo* at various stages of radiation sickness, considering the possible effects of hemolysis induced by foreign particles. Experiments on 85 300 to 500 g guinea pigs exposed to 350 to 400 r showed a slow drop in phagocytic number; the drop in animals irradiated with 400 r was smaller than in those exposed to 350 r. Administration of staphylococcus also induced a drop in the phagocytic number, however, the drop was not as catastrophic as that induced in the erythrocytes. The hemolysis titer on the 17th to 20th day after irradiation was 1 : 800 and 1 : 1000, while in control animals it was 1 : 1200 to 1 : 1600, indicating a certain depression in hemolysin production on exposure to 400 r. (R.V.J.)

**4403** COMPARATIVE CHARACTERISTICS OF MYELOPOIESIS IN INITIAL FORMS OF CHRONIC ACTION OF X-RAYS AND BENZOLE INTOXICATION. V. V. Sokolov, E. A. Solovieva, and P. A. Gribova. Med. Radiol., 7: No. 7, 92-3(July 1962). (In Russian)

Effects of chronic benzene intoxication and chronic exposure to small doses of x radiation on the hematopoietic system were studied. The obtained data indicated certain differences in the development of seemingly identical changes. (R.V.J.)

**4404** STATISTICAL STUDY ON THE MORTALITY FROM MALIGNANT NEOPLASMS IN NAGASAKI ATOMIC BOMB SURVIVORS. T. Mori (Nagasaki Univ.). Nagasaki Igakkai Zasshi, 35: 1633(1960).

A statistical study was performed on the mortality of Nagasaki atomic bomb survivors from malignant neoplasms during the last 5 years. The findings were compared with mortality statistics in Nagasaki Prefecture and in Japan. In the young age group there was a significantly higher mortality from malignant neoplasms in atomic bomb survivors than in Nagasaki Prefecture or in Japan. This high mortality rate was due to the increase in the number of deaths from malignant disease of the lymphoid and hemopoietic system. However, when the corrected death rates for three groups were compared, no significant differences were found. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4405** A STUDY ON THE RADIATION SENSITIVITY OF THE BLOOD CELLS OF VARIOUS ANIMALS. H. Horizawa (Nagoya Univ. School of Medicine, Japan). Nagoya Igaku, 83: 1179-1203(1960).

Dogs, rabbits, and ddN strain mice were subjected to single whole-body irradiation and their peripheral blood was examined from 3 hours to 4 weeks later. The minimal dose required to induce changes in the peripheral blood was compared with the LD$_{50}$/30 days (for dogs 300, rabbits 800, and mice 700 r). It was presumed that changes occurred with a dose of 1/2 × LD$_{50}$/30 days in the red cells, the hemoglobin content, and the color index, with 1/20 × LD$_{50}$/30 days in reticulocytes, leucocytes, and granulocytes, with 1/100 × LD$_{50}$/30 days in lymphocytes, and with 1/10 × LD$_{50}$/30 days in platelets. An increase in granulocytes with 1/20 × LD$_{50}$/30 days, and the appearance of dead leucocytes with 1/20 × LD$_{50}$/30 days was found in dogs, rabbits, and ddN strain mice. The minimal doses inducing minimal changes in blood cells for the animals showed relatively constant values regardless of the species of animal examined. In rabbits irradiated with 1/2 × LD$_{50}$/30 days there was no variation in the hematocrit values or in the diameter of the erythrocytes, but there was an increase in the mean cell volume and thickness of erythrocytes. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4406** STUDY ON X-IRRADIATION OF THE HYPOPHYSIS. I. EFFECT ON ADRENOCORTICAL FUNCTION. H. Miwa (Nagoya City Univ., Japan). Nagoya Shiritsu Daigaku Igakkai Zasshi, 11: 685-700(1960).

Combined therapy for mastopathia consisting of sex hormone and x irradiation of the hypophysis resulted in a shorter treatment period and administration of less sex hormone as compared with the single hormone treatment method. The hypophyseo-adrenocortical function was not stimulated by the androsterone given to the patient with mastopathia, which only neutralized the female sex hormone in the peripheral blood. The hypophyseo-adrenocortical function was regulated by irradiation of the hypophysis with 100 r. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4407** STUDY ON X-IRRADIATION OF THE HYPOPHYSIS. III. EFFECT ON WHOLE-BODY IMMUNITY. H. Miwa (Nagoya City Univ. Medical School, Japan). Nagoya Shiritsu Daigaku Igakkai Zasshi, 11: 701(1960).

Irradiation of the hypophysis with 100 r increased whole-body immunity and induced lymphopenia in the peripheral blood. However, after 1000 r the whole-body immunity appeared to be reduced and was associated with lymphocytosis in the peripheral blood. An increased whole-body immunity and lymphopenia also resulted from the administration of ACTH. A large dose of androsterone induced a reduction in the general immunity and a lymphocytosis. Therefore, there may be some relationship between the hypophyseo-adrenocortical function, the general immunity, and the lymphocyte count in peripheral blood. A reduction in the general immunity after androsterone was prevented by a 100 r irradiation of the hypophysis. As an increase in general immunity inhibited the proliferation of cancer cells, long-term administration of androsterone in breast cancer might be endocrinologically rational. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4408** EFFECT OF FEEDING X-RAY IRRADIATED COLIFORM BACILLI TO TUMOUR-BEARING MICE. Arthur Compton (Wright-Fleming Inst. and St. Mary's Hospital, London). Nature, 195: 1273-6(Sept. 29, 1962).

Preliminary findings are reported from an investigation of the effects of feeding irradiated coliform bacilli on the growth of transplanted tumors in mice. Initial inhibition of tumor growth was noted in a certain proportion of the treated animals. (C.H.)

**4409** TUMOUR DEVELOPMENT IN THE RAT INDUCED BY BLOOD OF IRRADIATED ANIMALS. José Souto (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Nature, 195: 1317-18(Sept. 29, 1962).

Female rats that received either blood plasma from irradiated rats or blood plasma ultrafiltrate from irradiated sheep showed a significant increase of tumors when compared with those injected with normal plasma or with physiological saline. Tumor incidence in male rats showed no significant differences between the groups. The time in which the first appearance of the tumor was noted was not significantly different between females injected either with plasma or ultra-filtrate and irradiated and normal animals. The histology of the tumors did not show appreciable differences in the relative frequency of each particular type between the groups injected with plasma or with ultrafiltrate from irradiated or from normal animals, either in males or females. The possibility is considered of other non-specific factors that may influence the number of tumors in rats. (C.H.)

**4410** VIABILITY OF EHRLICH ASCITES TUMOUR CELLS EXPOSED TO SODIUM CHROMATE LABELLED WITH CHROMIUM-51. P. C. Vincent (Royal North Shore Hospital, Sydney). Nature, 196: 179-80(Oct. 13, 1962).

Ascitic fluid was pooled from 3 mice with Ehrlich ascitic tumors and divided into 3 portions. One portion was incubated with $Na_2Cr^{51}O_4$, the second portion was incubated with saline, and the third portion was stored. All samples were adjusted to the same cell concentration and inoculated into test mice. All mice showed similarity of weight gain due to ascites. Serial replicate passage from each mouse produced vigorous growth through 8 transplant generations. It is concluded that $Na_2Cr^{51}O_4$ has no effect on the viability of Ehrlich ascites tumor cells even at high concentrations. (C.H.)

**4411** MODIFICATION OF RADIATION EFFECT ON MAMMALIAN TUMOUR CELLS BY PHARMACOLOGICAL AGENTS. R. J. Berry and J. R. Andrews (National Cancer Inst., Bethesda, Md.). Nature, 196: 185-6(Oct. 13, 1962).

Tumor-bearing mice were treated with 5-chlorodeoxyuridine (CUdR). Direct toxicity of the drug on reproductive capacity of the tumor cells was observed at the low dose of 100 mg/kg day for 4 days. Additivity of radiation and drug effect was noted in almost all groups, but no significant potentiation of the radiation effect was noted. Results are compared with those from previous studies using 5-iododeoxyuridine. (C.H.)

**4412** MECHANISM OF X-RAY INHIBITION OF THE SODIUM PUMP IN HUMAN ERYTHROCYTES: ADENOTRIPHOSPHATASE ACTIVITY OF STROMATA. Francesco Bresciani, Ferdinando Auricchio, and Cesare Fiore (Università, Naples). Nature, 196: 186-7(Oct. 13, 1962).

Previous results showed that x irradiation of human erythrocytes decreases the active efflux of Na. Results are reported from an investigation of the biochemical mechanisms in the membrane that underlies the active transport of Na across the cell membrane. The studies were made on human red cell ghosts. Adenosinetriphosphatase-splitting activity requiring Na and K was found to be particularly sensitive to x rays. The magnitude of this inhibition was in agreement with the decrease of Na active efflux. It was concluded that the mechanism of the Na pump is in the cell membrane and the inhibitory effect of x rays on the adenosinetriphosphatase-splitting activity of stromata that require Na and K is a result of inhibition of the metabolic cycle of the Na carrier. (C.H.)

**4413** THE EFFECT OF X-IRRADIATION ON EXPERIMENTAL PNEUMOCOCCAL INFECTION IN MICE, WITH SPECIAL REFERENCE TO THE INFLUENCE OF THE RADIATION TIME FACTORS. Y. Hidaka (Nihon Univ., Tokyo). Nichidai Igaku Zasshi, 19: Suppl., 3595-3620(1960).

Following whole-body x irradiation, mice were injected intraperitoneally with Diplococcus penumoniae type I after injecting a certain amount of antipneumococcal serum which was expected to protect against the injection. With administration of 500-r dose, the leukocyte count fell immediately, then gradually returned to the normal level. With a dose increased to 1000 r, the mice died due to a dramatic fall in the leukocyte count. A 50-r dose resulted in a transitory rise in the leukocyte count shortly after x irradiation, after which no significant changes were seen. With dose rates of 3.2 and 32 r/min., the injurious effect was less with the low intensity than with the high intensity irradiation. Thus it was concluded that the resistance of mice to pneumococcal infection was lowered inversely proportional to both the dose and the dose rate of x radiation. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4414** STUDIES ON THE EFFECTS OF THE RADIOACTIVE SUBSTANCE THOROTRAST, DEPOSITED IN THE ORGANS. H. Tokuhiro (Chiba Univ. School of Medicine, Japan). Nippon Ketsueki Gakkai Zasshi, 22: 683-98(1959).

Follow-up studies were made in 60 of 107 cases in which thorotrast had previously been used in the surgical clinics during 1934-1944; 7 were studied in detail by correlating the thorotrast deposit with the clinical picture. There was no case of malignant tumour following thorotrast. Subjective symptoms in 30 surviving patients were slight. But there were 4 cases which showed some evidence of local injury due to the chemical. BSP tests showed a delay in disappearance of the dye from the blood in 6 of the 7 cases in which the thorotrast deposit was confirmed. In some of them serum K was decreased, serum Fe and Cu were increased; some showed high values for $\gamma$ globulin, while there was a diminished $\gamma$ globulin in others. Liver biopsy in 1 case disclosed fibrosis, necrosis, and proliferation of the liver cells. Peripheral blood showed a relative lymphocytosis, hyperchromatosis, and macrocytosis, as well as the presence of erythrocytes with Howell-Jolly bodies. Comparative studies of the rate of appearance of such erythrocytes in the peripheral blood in the cases under investigation and in 223 control cases of various internal diseases, provided data which suggest that the patients with a thorotrast deposit may have atrophy and hypofunction of the spleen. The results of clinical studies, as well as of experiments carried out in rabbits, show that the effects of thorotrast on the peripheral blood picture depend on the amount injected and the period of time elapsing after injections, and that they also differ between humans and animals as well as from individual to individual. Biopsy clearly showed the presence of thorotrast particles in the bone marrow (also in the liver in some cases). Electron microscopy of the bone marrow cells of a case in which thorotrast had been used 20 years previously, showed the persistence of the granules. Various organs of rabbits into which the chemical had been injected were also studied with the electron microscope. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4415** RELATION BETWEEN X-RAY SENSITIVITY AND STAGES OF THE CELL CYCLE IN SPERMATOGONIA OF THE MOUSE. Valerio Monesi (Oak Ridge National Lab., Tenn. and Comitato Nazionale per l'energia Nucleare, Rome). Radiation Res., 17: 809-38(Dec. 1962).

Male mice were injected intraperitoneally with 15 $\mu$C of $H^3$-thymidine per mouse, x-irradiated 1 hour later with 20, 50, 100, 200, or 300 r, and killed at various time intervals afterward. Autoradiograms of 5-$\mu$ sections of the testes were prepared, and counts were made of the numbers of normal and necrotic, unlabeled and labeled, type A, intermediate, and type B spermatogonia. Results indicate that damaged spermatogonia die as they reach a definite, critical stage in the cell cycle, regardless of the stage at which they were irradiated. Cell death occurs in late interphase or very early prophase for type A and intermediate spermatogonia and in anaphase or telophase for type B spermatogonia. Type B spermatogonia are remarkably resistant to cell killing for a period of about 5 to 7 hours after completion of DNA synthesis. This period corresponds approximately to the duration of prophase. Interphase is the sensitive stage. Since type A and intermediate spermatogonia die before division, the fate of the cells irradiated while in mitosis escapes detection. If the conclusion of a high radioresistance during early division stages drawn for type B spermatogonia also might be applied to type A and intermediate spermatogonia, a key might be provided for the interpretation of the radiation response of mouse spermatogonia. Thus, the much longer duration of the x-ray-sensitive period (interphase) and the much shorter duration of the x-ray-resistant period (prophase) of the cell cycle in intermediate and type B spermatogonia in comparison to type A spermatogonia may possibly account for the greater x-ray sensitivity of intermediate and type B cells. Accordingly, the existence in the type A population of four cell generations each having different durations of the x-ray-sensitive and of the x-ray-resistant periods of the cell cycle offers a possible explanation for the heterogeneity of the radiation survival curve of these cells. (auth)

**4416** THE LETHAL EFFECTS OF ALPHA IRRADIATION ON WILD-TYPE AND ON A HIGH-CATALASE MUTANT OF RHEUDOPSEUDOMONAS SPHEROIDES. Roderick K. Clayton and P. S. Rudolph (Oak Ridge National Lab., Tenn.). Radiation Res., 17: 839-46(Dec. 1962).

Wild-type Rhodopseudomonas spheroides and a high-catalase mutant were studied with regard to the lethal actions of $\alpha$-particles from radon and of reagent $H_2O_2$. The catalase of the mutant affords marked protection against $H_2O_2$ but not against $\alpha$-particles. The killing by $\alpha$-irradiation was not changed materially by altering the cell suspension density or by the presence of oxygen during irradiation. Application of target theory indicated that a cell loses viability if any part of it is intersected by the track of an $\alpha$-particle. Exposure of wild-type R. spheroides cells to externally applied 1 M $H_2O_2$ for 30 seconds reduced the viable count by 50%. It was concluded that $H_2O_2$ in its ground state does not play a significant part in mediating the lethal action of $\alpha$-particles on R. spheroides. (auth)

**4417** THE EFFECT OF IRRADIATION ON REPRODUCTION IN TWO STRAINS OF TRIBOLIUM CASTANEUM HERBST. Alan C. Bartlett and A. E. Bell (Purdue Univ., Lafayette, Ind.). Radiation Res., 17: 864-77(Dec. 1962).

The effects of x radiation on the reproductive performance of two strains of Tribolium castaneum were measured. The two strains differed in body weight, one strain being two and one-half times as heavy as the other. Females of the heavier strain were more resistant to somatic damage than were females of the light strain. Genetic damage, as measured by a reduction in fertility of irradiated individuals, was not so great in the heavy strain as in the light strain, especially when both parents were irradiated. When only one parent in a mating was irradiated, no sex differences in response to increasing dose were found. When both parents of a mating were treated, since the effective dose was doubled, there was a greater increase in genetic damage than if only one parent were treated. The effect of irradiating both parents can be predicted from the results obtained when only one parent is irradiated. The response curve for somatic damage showed a linear decline at high doses (1000 and 5000 r) but no significant effect at low doses (0 to 800 r). The response curve for genetic damage, as measured by an orthogonal polynomial analysis, was sigmoid in shape with a linear decline at low doses and a curvilinear decline at the high doses. The genetic response curve over all doses can be fitted to a function of the type $Y = a + bX + cX^2$, where the different coefficients of X and $X^2$ change with the strain. The coefficients also depend on whether one or both parents are treated. The drop in fertility at doses over 5000 r was an average of 66.9% for irradiated foundation adults (summed over mating combinations) and an average of 58.8% for irradiated selected adults. (auth)

**4418** EVALUATION OF RADIATION RESPONSE AS AN INDEX OF AGING IN MICE. John B. Storer (Roscoe B. Jackson Memorial Lab., Bar Harbor, Maine). Radiation Res., 17: 878-902(Dec. 1962).

Life table data were obtained on 3904 RF/J female mice. Approximately half the mice received 400 r of x rays at 90 days of age. Gross mortality rates in the irradiated population showed marked departures from the Gompertz equation. Median life span was shortened by 178 days. Correction of mortality rates for leukemia incidence enabled a reasonably good fit of the Gompertz equation to data from both populations. The corrected data indicated a life shortening of 24 days per 100 r of exposure. No latent period between time of exposure and a detectable increase in mortality rate relative to the control rate was found. The mortality rate in the irradiated population was higher at all time intervals after exposure. The $LD_{50(30)}$ was found to decline approximately linearly with age. No pronounced effect of previous exposure was observed. Survival under daily exposure to 100 r/day declined with age in a complex manner. Previously irradiated animals were generally more sensitive than controls. The recovery rate as estimated by split doses declined sharply with age. Recovery rates in previously irradiated mice were considerably lower than those in controls of comparable ages. None of the radiation responses measured showed a consistent relationship to mean life expectancy. It was concluded that radiation exposure does not cause a true, nonspecific, premature aging but selectively damages certain organ systems. (auth)

**4419** EFFECTS OF X-IRRADIATION ON PHOSPHOLIPID METABOLISM. I. INVESTIGATION OF $P^{32}$ UPTAKE INTO INDIVIDUAL LIVER AND SPLEEN PHOSPHATIDES OF NORMAL AND IRRADIATED MICE. Theresa C. Lee, Robert J. Salmon, Merle K. Loken, and Donn G. Mosser (Univ. of Minnesota, Minneapolis). Radiation Res., 17: 903-13(Dec. 1962).

Phospholipids, tagged with $P^{32}$, of liver and spleen of normal and irradiated mice were separated by silicic acid column chromatography. The specific radioactivity of the total phospholipids and of seven groups of phosphatides was determined at various times after the injection of the $P^{32}$ in both normal and irradiated animals. The uptake of $P^{32}$ into the total liver phospholipids was higher in the irradiated animals than in the controls. This was due to increased specific activity of the cephalins and lecithins. The specific activity of inositides and lysolecithin was not greatly changed by irradiation, whereas that of the sphingomyelins was increased at 2 and 4 hours but decreased after 8 hours. The specific radioactivity of liver phospholipids reached a maximum at 8 hours after injection of the $P^{32}$ in normal animals but occurred at 6 hours in the irradiated animals. (auth)

**4420** EFFECTS OF IONIZING RADIATION ON THE FINE STRUCTURE AND FUNCTION OF THE INTESTINAL EPITHELIUM OF THE MOUSE. I. VILLUS EPITHELIUM. Henry Quastler and James C. Hampton (Brookhaven National Lab., Upton, N. Y. and Univ. of Texas, Galveston). Radiation Res., 17: 914-31(Dec. 1962). (BNL-6077)

The effects of ionizing radiation on villus epithelial cells were studied at the electron-microscope level. Within 10 minutes after irradiation with 200 rads or more, the cell membrane showed morphological evidence of softening. Within 1 hour after administration of 3000 rads, alterations in the organization of mitochondrial cristae were found, and it was observed that such alterations became more general with passage of time until virtually all mitochondria were affected by days 4 and 5. Changes in nuclei, consisting in increase in size and in irregular contour, and the appearance of myeloid figures in the cytoplasm occurred with increasing frequency with increasing time interval after irradiation. Corn oil was absorbed and transported across the epithelium in about normal amounts by cells which were on the villus at the time of irradiation. But cells appearing on the villus at 2 days and later showed a decrease in absorption and minimal transport across the epithelium. Cells from animals sacrificed 2 to 5 days after treatment showed a progressive depletion of ribonucleoprotein granules and a significant decrease in the number of mitochondria and membrane-bound vesicles. Possible interrelations of the observations are presented and discussed. (auth)

**4421** DOSE-RATE DEPENDENCE OF EARLY RADIATION EFFECTS IN SMALL MAMMALS. J. L. Bateman, V. P. Bond, and J. S. Robertson (Brookhaven National Lab., Upton, N. Y.). Radiology, 79: 1008-14(Dec. 1962). (BNL-6241)

A compilation was made of thirty-day 50% lethality studies in the literature on rats or mice exposed to x or gamma radiation and one study of human skin threshold. All studies showed radiation effectiveness to vary with the cube root of dose rate. For most of the studies plotted in the described co-ordinate system, derived formulas differed only in one term, the effect dose at infinite dose rate. The criteria of effect, therefore, all show the same fractional change in dose needed (to accomplish a given effect) between any two dose rates compared. No difference in dose rate effect was evident between x and gamma radiation, or between rats and mice. No specific recovery mechanism was implicated by the preceding derived relationship of effect dose to dose rate, which probably expresses the net effect of several mechanisms operative on different levels of organization. (auth)

**4422** THE DYNAMICS OF THE RETICULOENDOTHELIAL SYSTEM AFTER RADIATION INJURY. Friedhelm Hess (Universität, Marburg, Ger.). Strahlentherapie, 119: 161-76(Oct. 1962). (In German)

Direct radiography of storage and release of a substance, which can be phagocytized like heat-denatured $I^{131}$-human serum albumin disclosed new possibilities in observing the dynamics of the RES. Change of function under the influence of whole and partial body radiation is described and evaluated. The results show susceptibility to radiation of the RES, but also show, that reparative reserves of the system, which is so important for body-resistance, are sufficient to prevent a break-down of function even after higher doses of radiation. (auth)

**4423** ESTIMATION OF PREGNANCIES AFTER ACTION OF IONIZING RADIATION ON THE GONADS. Richard

Kepp (Universitäts-Frauenklinik, Giessen, Ger.). Strahlentherapie, 119: 187-93(Oct. 1962). (In German)

Damage to the $F_1$-generation after irradiation of the gonads is felt possible according to results obtained in animal experiments and previous experiences obtained in humans. Consequences observed in humans are displacement in sex and increased miscarriages, but an increased frequency in deformities has not been observed so far. (auth)

**4424** RADIOBIOLOGICAL INVESTIGATION OF SIEVE AND SCREEN IRRADIATION. PART 3. EXPERIMENTAL ANIMAL STUDIES OF THE IMPORTANCE OF VARIOUS FORMS OF SPATIAL FRACTIONATION FOR THE SKIN PRESERVATION EFFECT OF SIEVE IRRADIATION. Ludwig Rausch (Universität, Marburg, Ger.). Strahlentherapie, 119: 209-25(Oct. 1962). (In German)

The importance of different forms of the spatial fractionation (circumference/area-ratio) for skin protection was investigated. Experiments with the perforation-hole healing-test on the rabbit ear showed that almost the same biological effects were obtained with normal and reciprocal sieves with the same sieve data. Furthermore, a significant improvement of the healing rate with increasing circumference/area-ratio resulted with conventional as well as with reciprocal sieves. The results are in good agreement with clinical experiences using fine sieves. The effect depends upon the dose and not upon the hole diameter, using guinea pig epilation as a test. (auth)

**4425** INVESTIGATION OF CALCIUM METABOLISM IN THE EPI- AND METAPHASES AFTER LOCAL ROENTGEN IRRADIATION. PART III. THE FORMATION OF $Ca^{45}$. Jaromir Kolar and Arnost Babicky (Univ. of Prague and Inst. Of Biology, Czechoslovak Academy of Sciences, Prague). Strahlentherapie, 119: 236-49(Oct. 1962). (In German)

Observations are reported on 2 day storage of $Ca^{45}$ by white rats, which received local bone injuries from x rays of 750 and 3000 r. It was observed, that the storage was smaller with greater radiation injury. Furthermore, it was found that not only the irradiated but also the unirradiated bones reacted to the local radiation injury. Even bones belonging to another anatomical group and other calcificated tissues (teeth) reacted. Reduction of the storage ability was not uniform, but was accompanied by multiple fluctuations. The observations indicate efforts of the organism to normalize conditions, which are changed not only in the irradiated but also in the unirradiated bones. (auth)

**4426** STUDIES ON THE EFFECTS OF X-IRRADIATION ON THE HAEMOGRAM OF RABBITS. EFFECTS FROM LOCAL IRRADIATION OF THE ABDOMINAL SKIN. T. Nakagawa (Tokyo Medical Coll.). Tokyo Ikadaigaku Zasshi, 18: 1303-28(1960).

By daily irradiation of part of the abdominal skin for 6 days, red and white cell counts increased with exposures to 300, 100, and 600 r daily in that order of effect. When the daily dose was as high as 1000 r, both cell counts increased during irradiation, but they decreased after irradiation. Hemoglobin increased at first but decreased later with daily irradiations of 100, 300, and 600 r, but it decreased from the beginning with daily irradiations of 1000 r. The pseudo-eosinophil count increased temporarily in all cases. It fluctuated later with daily irradiations of 100, 300, and 600 r and decreased markedly after about the third day of daily irradiations of 1000 r. The lymphocyte count increased with daily irradiations of 300 r, less so with daily irradiations of 100 r and only slightly so with daily irradiations of 600 r. It decreased markedly with daily irradiations of 1000 r. The average nuclear count showed no marked change with daily irradiations of 100 r, but a slight shift to the right was observed with daily irradiations of 300 and 600 r, and a tendency to shift to the left with daily irradiations of 100 r. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4427** EFFECT OF THE INTERNAL IRRADIATION BY RADIOACTIVE PHOSPHORUS ON THE HAEMOPOIETIC SYSTEM. I. DAMAGE AND RECOVERY OF HAEMOPOIETIC TISSUE AFTER THE INTRAPERITONEAL INJECTION OF A MODERATE AMOUNT OF $P^{32}$. M. Sagawa (Yamaguchi Prefecture Medical School, Ube, Japan). Yamaguchi Igaku, 9: 1198-1203(1960).

Five μc/g of $P^{32}$ were injected intraperitoneally in adult rats. Myelogenous cell density in the bone marrow of the femur was rapidly reduced, reaching its minimum value 10 to 14 days after the injection. The reproductive activity for erythrocytes decreased to less than one tenth of its normal level by the 5th day and was practically absent by the 10th day; however, activity was fully restored by the 30th day. The reproductive activity for granulocytes showed similar changes to that for the erythrocytes, although the erythrocytes were generally more radiosensitive than the granulocytes. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4428** EFFECT OF THE INTERNAL IRRADIATION BY RADIOACTIVE PHOSPHORUS ON THE HAEMOPOIETIC SYSTEM. II. COMPARISON OF THE EFFECTS OF INTERNAL IRRADIATION BY RADIOACTIVE PHOSPHORUS AND OF WHOLE-BODY X-IRRADIATION ON THE HAEMOPOIETIC SYSTEM. M. Sagawa (Yamaguchi Prefecture Medical School, Ube, Japan). Yamaguchi Igaku, 9: 1204 (1960).

Whole-body x irradiations of 600 r and intraperitoneal injections of 5 and 8 μc/g of radioactive phosphorus were given to rats of the Wistar strain. The reductions in the bone marrow, spleen, mesenteric lymph nodes, and thymus cell counts were studied. The administration of 5 μc/g of $P^{32}$ gave the same level of change in the hemopoietic system as did the external x irradiation. When 8 μc/g were given, the effects were much greater than with 600-r irradiation. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4429** ELECTRON RESONANCE STUDY OF SECONDARY REACTIONS IN AN X-IRRADIATED FIBROUS PROTEIN. B. Rajewsky and A. Redhardt (Max Planck-Institut für Biophysik, Frankfurt am Main). Z. Naturforsch., 17b: 569-71(Aug. 1962). (In German)

Electron spin resonance signals were investigated for the detection of secondary reactions in solid proteins. The time behavior of the ESR signal in quills, which had been exposed to 2.8 Mrad in 7 min, was determined. The difference between the saturation value and the instantaneous values of the ESR and the velocity constant as a function of the reciprocal of the absolute temperature were determined. It was concluded that a given radical after the end of irradiation is slowly formed with the assistance of diffusion processes. (J.S.R.)

**4430** BIOLOGISCH-CHEMISCHER STRAHLENSCHUTZ. EINE ÜBERSICHT IN TABELLEN. [BOOKS] I [AND] II. (Biological-Chemical Radiation Protection. A Survey in Tables. [In Two Parts]). Rudolf Huber and Ernst Spode. Berlin, Akademie-Verlag, 1961. DM 124.

A survey of previous works on radiation protection is presented. Results are presented in tables for sulfhydryl compounds and related materials, amino acids, amines, heterocyclic compounds, proteins, alcohols, carbohydrates, organic acids, vitamins, hormones, organ and tissue homogenates and extracts, materials affecting the nervous system, blood transfusions, parabiose, antibiotics, sulfonamide, cyanic compounds and other poisons, antihistamines, aromatic oxy-compounds and related materials, inorganic and organic salts, and miscellaneous materials. Author, source, and subject indexes are included. (M.C.G.)

**4431** PHYSICAL FOUNDATIONS OF RADIOLOGY. Third Edition, Revised and Enlarged. Otto Glasser, Edith H. Quimby, Lauriston S. Taylor, J. L. Weatherwax, and Russell H. Morgan. New York, Paul B. Hoeber, Inc., Dec. 1961. 503p.

A compact, elementary, and essentially nonmathematical guide to radiation physics is presented for the guidance of physicians and students. Physical principles are considered only in so far as they are required for an understanding of medical radiology. Emphasis is placed on advances in recent years in both the theory and practical applications of radiation physics, the development of radiation measuring instruments, and applications in measurements of roentgen-ray quality and tissue doses, dosage calculations with radioactive materials, and radiation protection. Depth-dose tables are included. (C.H.)

## Radiation Sickness

*Refer also to abstract 4754.*

**4432** TWO-STEP TRANSPLANTATION THERAPY IN LETHALLY IRRADIATED MICE. Alena Lengerovâ and Marta Vojtiškovâ (Inst. of Experimental Biology and Genetics, Czechoslovak Academy of Sciences, Prague). Folia Biol. (Prague), 8: 288-95(1962). (In English)

Attempts were made to form mouse radiation chimeras potentially capable of undergoing further transplantation therapy and accepting grafts from a second donor, unrelated to both host and the first donor of the restorative cell graft of myeloid and lymphoid tissues. Different approaches were tested in an attempt to modify the immune reactivity conferred on the irradiated recipient with the restorative graft from the first donor by inducing tolerance to a prospective second donor. Male radiation sterility was found to be an unsatisfactory experimental model for transplantation therapy. It was also difficult to decide whether an intratesticular cell graft by itself would be able to induce tolerance or rather to escape immunity on the part of the chimera host. In further experiments, test grafts were either heterotopically transplanted ovaries in female radiation chimeras, skin grafts, or both. The behavior of ovarian tissue did not differ from that of skin when used as test-graft in presumably tolerant recipients. The tissues either both took or were both rejected. Survival of grafts from a second donor was obtained only when tolerance to its specific antigens was first induced in the restorative cell graft by an admixture of cells of its genotype or of pooled cells from many donors belonging to an antigenically heterogeneous mouse population. Solid tissue (skin) was not a satisfactory source of antigenic stimulus for the induction of graft-to-graft tolerance. The limits to the use of the principle of antigenic overlapping for the induction of polyvalent immunological tolerance of tissues from donors selected at random are discussed. (auth)

**4433** THE PROBLEM OF AUTOINFECTION AFTER TOTAL BODY LETHAL IRRADIATION OF DOGS WITH $^{60}$Co. Hana Puzovâ, Katarina Szabovâ, J. Čerman, A. Puza, E. Kunštadt, and M. Zaduban (Safarik Univ., Kosice, Czechoslovakia). Folia Biol. (Prague), 8: 298-308(1962) (In English)

The role of autoinfection was studied as one of the causes of death in dogs exposed to lethal whole-body irradiation. Three-month-old puppies with an average weight of 3800 g were irradiated with a single whole-body dose of Co$^{60}$ totaling 750 r. The origin of autoinfection and time of infiltration of the bacteria into the blood and organs were studied. The time sequence of penetration of the bacteria from the intestine into the blood and organs was determined. Bacteria were demonstrated in the mesenteric lymph nodes on the second and fourth days after irradiation. In one case, they were also demonstrated in the liver. Between the fourth and seventh days a relative decrease in the number of bacteria was observed. From the eighth day after irradiation, progressive mass invasion of the organs by bacteria of intestinal origin occurred. Between the eighth and tenth day after irradiation, bacteria were demonstrated in the mesenteric lymph node, spleen, liver, kidneys, and blood from the heart. By the twelfth day penetration progressed to such an extent that bacteria could be demonstrated in all the organs examined and also in blood from the heart. The average complement titre before irradiation was 1 : 12 (1 : 11.9). After irradiation a slight increase in complement was observed. A distinct increase in complement was found in three control animals which survived irradiation for more than ten days. In one control animal, which died on the tenth day, a mild decrease was recorded. In five experimental animals killed on the tenth and twelfth day after irradiation, a marked decrease was found. (auth)

**4434** SURVIVAL RATE OF INDIVIDUALS WITH A RADIATION-INDUCED HETEROGENOUS LETHAL FACTOR. C. Ohshima and O. Kitagawa (National Inst. of Genetics, Mishima, Japan). Kokuritsu Idengaku Kenkyujo Nempo, 10: 105(1960).

A series of 27 lethal factor genes ($l_1-l_{27}$) was obtained with Drosophila melanogaster, which have a lethal gene in the chromosome of the 2nd, and Samarkand (SK) in the 1st and 3rd generation. The second gene was always maintained in the form of Cy/1. By intercombination, the lethal genes in the chromosomes of the series were considered to be situated in the same places with $l_{13}$ and $l_{20}$, but in different places with others. Juvenile survival rate of heterogenous population with lethal genes was 0.9332 as an average of 27 series. This indicated that in the homogenous genetic background the lethal genes lower the survival rate by 7%. On the other hand, with the combination of Cy/l females and males chosen from the high heterozygosity group without distinction instead of SK males, the relative survival rate of 1/+ was determined as 1.0114, in the same way. This indicated that the lethal genes become recessive in the heterogenous genetic background. In each series in the homogenous genetic background, 6 from 27 showed significant decrease in the survival rate and the survival rates among the series had 5% significant difference. But in the heterogenous background, no such decrease was present. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4435** THE EFFECT OF PLACENTAL PLASMA ON X-RAY DERMATITIS. A. Nakamura (Kurume Univ. School of Medicine, Japan). Kurume Igakkai Zasshi, 23: 924-47 (1960).

Four cases of x-ray dermatitis were treated by placental plasma. Chronic local pain disappeared rapidly and the ulcer gradually became smaller, leading finally either to complete healing or to marked improvement. Animals were given a dose of fractional 5000 r and the cutaneous changes were studied microscopically. In control animals an incurable ulcer appeared and the hair fell out, but in treated animals the ulcer never occurred and their hair began to grow after 8 weeks. The histological changes did not differ fundamentally between the two groups but the intensity of every change was appreciably slighter in treated animals than in controls. Changes in the blood picture were also very slight in the treated animals. (Abstr. Japan Med., 2: No. 10, Oct. 1962)

**4436** THE INFLUENCE OF PROPHYLACTIC STIMULATION OF THROMBOCYTOPOIESIS ON THE DEVELOPMENT OF HEMORRHAGIC SYNDROME DURING IONIZING RADIATION. N. V. Traskunova (Central Scientific-Research Inst. of Medical Radiology, Ministry of Public Health, USSR). Med. Radiol., 7: No. 7, 45-50(July 1962). (In Russian)

It is shown that diphacyl in certain conditions stimulates the thrombocytopoiesis in healthy guinea pigs. Repeated diphacyl injections to healthy animals led to a more prolonged stimulation of the thrombocytopoiesis. The possibility of reducing the markedness of thrombocytopenia following prophylactic introduction of diphacyl in acute radiation sickness was studied. The hemorrhagic syndrome was marked to a lesser degree in animals subjected to prophylactic injections of diphacyl. (auth)

**4437** GAS EXCHANGE CHANGES IN RATS FOLLOWING INTRAPERITONEAL ADMINISTRATION OF CYSTEIN AND CYSTEAMINE. A. Vatsek (Brno Inst. of Biophysics, Czechoslovak Academy of Sciences). Med. Radiol., 7: No. 7, 57-62(July 1962). (In Russian)

The general consumption of oxygen and elimination of carbon dioxide in rats following intraperitoneal administration of cysteine (50-1,000 mg/kg) and cysteamine (50-200 mg/kg) were studied for the purpose of determining the state of metabolic processes during which the animals are protected from the action of ionizing radiation. The results obtained, particularly, the role of general oxygen consumption in the mechanism of protective action of cysteine and cysteamine are discussed. (auth)

**4438** THE SENSITIVITY OF THE ORGANISM TO PHARMACOLOGICAL SUBSTANCES IN $Sr^{90}$ AFFECTION. A. M. Ivanitskii. Med. Radiol., 7: No. 7, 72-4(July 1962). (In Russian)

In experiments staged on rats with subacute radiation sickness induced by intraperitoneal administration of 1.5 mC/kg of radiostrontium, the changes of resistance to pharmacological preparation were studied. Special attention was paid to neurotropic substances. In the affected rats the resistance to pharmacological agents peculiar to healthy animals was preserved to a considerable extent. The greatest drop of resistance was noted in respect to hexanal, a narcotic agent. (auth)

**4439** ON PROTECTIVE AND RESTORATIVE REACTIONS IN ORGANISMS DURING RADIATION SICKNESS. N. K. Sviridov and E. G. Parfenova. Med. Radiol., 7: No. 7, 89-90(July 1962). (In Russian)

The recticulo-endothelium activity, blood flow, and restorative processes in morphological blood composition during acute radiation sickness were studied in 29 dogs exposed to a single dose of 600 r at 100 cm distance. Chemical therapy of 15 dogs resulted in a larger percentage of survival than in control dogs and faster restoration of the bone marrow and peripheral blood due to a lighter course of sickness. (R.V.J.)

**4440** RADIOPROTECTIVE EFFECTS OF $\beta$-AMINOETHYLISOTHIURONIUM Br · HBr IN THE DOG. John R. Newsome, David H. Knott, and R. R. Overman (Univ. of Tennessee, Memphis). Radiation Res., 17: 847-54(Dec. 1962).

It is shown that AET can be tolerated by dogs when administered by rapid intravenous injection in doses sufficient to be radioprotective (125 mg/kg). Also, AET was found to afford a high degree of protection (90% survivors) in large animals (dogs) against an otherwise lethal exposure of x irradiation. All control dogs given 500 r died. (auth)

**4441** POSSIBILITIES FOR BIOCHEMICAL RADIATION PROTECTION FOR LENS OF EYE. Ernst Krokowski and Heinfried Tiburtius (Freien Universität, Berlin). Strahlentherapie, 119: 300-7(Oct. 1962). (In German)

Three possibilities for biochemical radiation protection of the lens of the eye were investigated: dehydration, sulfhydryl compounds, and cellular therapy. None of the treatments gave absolute protection. Only a reduction of the radiation damage was found in some cases. (auth)

**4442** ANTIOXYDANTS AND SURVIVAL RATE OF WHOLE-BODY IRRADIATED MICE. Rudolf Huber and Ellinor Schroeder (Robert-Rössle-Klinik der Deutschen Akademie der Wissenschaften, Berlin). Strahlentherapie, 119: 308-15(Oct. 1962). (In German)

$\alpha$-tocopherol acetate, $\alpha$-tocopherol, and propylgallate were investigated for their probable property as radioprotective substances, using male AB-, C57bl/6-, and white mice. Between 500 and 1000 r whole-body irradiation, $\alpha$-tocopherol acetate showed an effect, proven statistically, on the survival rate (30 days) or survival time; the effect was limited to a narrow range of dose of the substances and was influenced by individual factors. Also, propylgallate increased the survival rate (30 days) at a dose of 750 r. The effect of the substances as only antioxydants against radiogenic peroxides was questionable. The effect of the radical scavenings is discussed. The influence of nutrition as well as unknown factors, which cause a different radiosensitivity for different strains, and also, their influence on the effect of the radioprotective substances is pointed out. (auth)

# CHEMISTRY

## General and Miscellaneous

**4443** (AFOSR-2542) APPLICATIONS OF NUCLEAR QUADRUPOLE RESONANCE. G. A. Jeffrey and Tosio Sakurai (Pittsburgh. Univ.). [1961]. Contract AF49 (638)-323. 68p. (AD-276141)

The nuclear quadrupole resonance depends primarily on interaction between the nuclear quadrupole moment and the electric field gradients which result from charge distribution in solids. For this reason many aspects of electronic structure in crystalline solids can be explored by this method. A review of applications which were developed between 1956 and 1961 is presented. (J.R.D.)

**4444** (IS-500) ANNUAL SUMMARY RESEARCH REPORT IN CHEMISTRY, ENGINEERING, METALLURGY AND PHYSICS, JULY 1, 1961–JUNE 30, 1962. (Ames Lab., Ames, Iowa). Sept. 1962. Contract W-7405-eng-82. 337p.

A total of four sections containing technical data is included in the report. Separate abstracts were prepared for each section. (J.R.D.)

**4445** (IS-500(Sect.C)) CHEMISTRY. (Ames Lab., Ames, Iowa). 114p.

Details of work in chemistry are given in sections on physical and inorganic chemistry reported under 32 sub-topics, pyrometallurgy with 4 sub-topics, analytical chemistry with 15 sub-topics, spectrochemistry with 4 sub-topics, radiochemistry with 8 sub-topics, and structural chemistry with 3 sub-topics. (J.R.D.)

**4446** (IS-500(Sect.E)) ENGINEERING. (Ames Lab., Ames, Iowa). 37p.

Details of engineering work are given in sections on chemical engineering, reported under 18 sub-topics, nuclear engineering with 2 sub-topics, mechanical engineering with 1 sub-topic, and ceramic engineering with 6 sub-topics. (J.R.D.)

**4447** (IS-500(Sect.M)) METALLURGY. (Ames Lab., Ames, Iowa). 105p.

Details of work in metallurgy are presented in sections concerning preparation of high-purity V, Nb, Th, Y, Cr, and W. Other work is reported on phase equilibria in selected alloys, mechanical properties of metals and alloys, solid state investigations, separation studies, and miscellaneous investigations on metals, alloys, and salts. (J.R.D.)

**4448** (IS-500(Sect.P)) PHYSICS. (Ames Lab., Ames, Iowa). 72p.

Details of the work during the period are given in sections on nuclear physics, reported under 19 sub-topics, nuclear spectroscopy with 3 sub-topics, and solid state experimental results with 22 sub-topics. (J.R.D.)

**4449** THE SEARCH FOR TECHNETIUM IN NATURE. B. T. Kenna (Univ. of Arkansas, Fayetteville). J. Chem. Educ., 39: 436-42(Sept. 1962). (SCR-556)

A historical account of element 43 is presented in four phases: (1) the searches and claims prior to its actual discovery in 1937; (2) its discovery and the preparation and identification of its isotopes; (3) its discovery in stars and the theories to explain its presence there; and (4) the recent searches for naturally occurring terrestrial technetium. (D.L.C.)

**4450** PREPARATION AND PROPERTIES OF SOME HYDROCARBON-SOLUBLE CERIUM AND IRON COMPOUNDS. H. R. Baker, R. E. Kagarise, J. G. O'Rear, and P. J. Sniegoski (U. S. Naval Research Lab., Washington, D. C.). J. Chem. Eng. Data, 7: 560-3(Oct. 1962).

Work is reported on the preparation and chemistry of organic Ce and Fe compounds which are possible intermediates in the stabilization of silicone liquids against oxidation and gelation. The compounds are basic ceric toluate, ceric toluate, cerous toluate, basic ceric dinonylnaphthalenesulfonate, ceric isopropoxide solvate, bis(N,N'-disalicylalpropylenediamine)cerium(IV), basic ferric toluate, N,N'-disalicylalpropylenediamine ferritoluate, and bis(N,N'-disalicylalpropylenediamine) ferrioxide. (D.L.C.)

**4451** A NEUTRON-ACTIVATION STUDY OF THE SOLUBILITY OF MERCURY IN WATER. S. S. Choi and D. G. Tuck (Univ. of Nottingham, Eng.). J. Chem. Soc., 4080-8(Oct. 1962).

A method was developed for the neutron activation analysis of mercury in aqueous solution. The limits of sensitivity of the method are calculated, and it is shown that $10^{-9}$ g of Hg can be detected. The method was applied in studies of the solubility of mercury in water over the temperature range 25 to 90°. The preparation of completely air-free solutions, and the sampling and irradiation methods, are described. The results, which show good internal agreement, are compared with other values in the literature. (auth)

**4452** DIOXANE ADDITION COMPOUNDS OF SOME BIVALENT METAL PERCHLORATES. E. Giesbrecht, W. G. R. de Camargo, G. Vicentini, and M. Perrier (Universidade, São Paulo, Brazil). J. Inorg. & Nucl. Chem., 24: 381-6(Apr. 1962). (In English)

The reactions between dioxane and the hydrated beryllium, magnesium, calcium, copper, zinc, strontium, cadmium, barium, mercury, and lead perchlorates are described. X-ray powder patterns and infrared absorption spectra of the obtained compounds are also presented, together with data for Mn, Fe, Co, and Ni, similar compounds already described elsewhere. (auth)

**4453** THE EXTRACTION OF NITRIC ACID BY LONG CHAIN TERTIARY AMINES. F. Baroncelli, G. Scibona, and M. Zifferero (Università, Rome). J. Inorg. & Nucl. Chem., 24: 405-13(Apr. 1962). (In English)

Nitric acid is extracted into benzene solutions of long chain tertiary amines to an extent which is in excess of the quantity required for salt formation. This excess is due partly to the extractive properties of the benzene and partly to the properties of the amine nitrate solution. For the portion of acid extracted by the amine salt, a partition coefficient is introduced which is a linear function of the amine concentration. Simple equations are given to compute the amount of $HNO_3$ extracted into the organic phase in a wide range of acid concentration (0 to 16 $\underline{M}$) and amine concentration (0.05 to 1 $\underline{M}$). To obtain information on the nature of the nitric acid present in the organic phase, infrared spectroscopy was used. The existence of ion pairs $[R_3NH^+NO_3^-]$ was shown. An increase of the amine nitrate concentration promotes the formation of higher orders of association. (auth)

**4454** INTERACTIONS BETWEEN TRIBUTYL PHOSPHATE, PHOSPHORIC ACID AND WATER. C. E. Higgins and W. H. Baldwin (Oak Ridge National Lab., Tenn.). J. Inorg. & Nucl. Chem., 24: 415-27(Apr. 1962). (In English)

The distribution coefficient for phosphoric acid between tributyl phosphate (TBP) and water increased with the acid concentration in the inorganic phase and correlated with the water behavior in the organic phase. Water accompanying the acid into the TBP was salted out after the ratio 3 TBP$\cdot$ $H_3PO_4 \cdot 6\ H_2O$ was reached but leveled off at one water per TBP regardless of the phosphoric acid concentration over the range 1 to 4 moles $H_3PO_4$ per mole TBP. Evidence for a high degree of association in solutions of anhydrous $H_3PO_4$ and TBP was obtained from ebullioscopic molecular weight determinations in ether and the viscosity of undiluted solutions. The maximum viscosity occurred at the 3 $H_3PO_4$ to 1 TBP ratio and was about three times that of anhydrous, super-cooled $H_3PO_4$. (auth)

## Analytical Procedures

*Refer also to abstracts 4807 and 5059.*

**4455** (DP-771) ANALYTICAL TECHNIQUES FOR THE USE AND CONTROL OF TRITIUM AT SAVANNAH RIVER. Edward L. Albenesius and Leon H. Meyer (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1962. Contract AT(07-2)-1. 18p.

Methods of tritium analysis that are used to monitor the potential health hazard and to control processes for tritium production at Savannah River are reviewed. The analytical applications of tritium produced in fission are also discussed. (auth)

**4456** (DP-772) A POLAROGRAPHIC TEST FOR SOLVENT QUALITY. PART II. POLAROGRAPHIC BEHAVIOR OF "ADAKANE" 12–TRIBUTYL PHOSPHATE. Robert C. Propst and John C. Simms (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1962. Contract AT(07-2)-1. 12p.

Polarographic waves that are proportional to the degree of degradation are exhibited by "Adakane" 12–tributyl phosphate solvent that is used in the Purex process for the processing of irradiated natural uranium. The simplicity and reproducibility of the polarographic test make it an attractive method for measuring solvent quality. (auth)

**4457** (GA-3358) RESEARCH STUDIES ON ANALYSIS OF IONIZED GASES. Final Report. William R. Snow (General Atomic Div., General Dynamics Corp., San Diego, Calif.). July 31, 1962. Contract DA-49-146-XZ-049. 19p. (DASA-1329)

The appearance of a large mass 12 peak in pure helium afterglows prompted further investigations, from which it is believed that the mass 12 peak is carbon from a CO impurity, probably a result of outgassing of the walls of the discharge chamber. Mixtures of oxygen with helium and neon have been examined in an attempt to measure the $O^+$ to $O_2$ charge transfer rate. Afterglows in hydrogen, water vapor, and nitrogen–hydrogen mixtures have also been studied. (auth)

**4458** (GAT-T-1050) SOME PROBLEMS OF MEASUREMENT PRECISION OF ELECTRON DIFFRACTION PATTERNS. Karl E. Beu (Goodyear Atomic Corp., Portsmouth, Ohio). July 13, 1962. Contract [AT(33-2)-1]. 20p.

Some of the factors that affect the accuracy with which diffraction ring diameters can be measured and their relation to the precision of measurement attainable in electron diffraction are discussed. Experimental conditions for attaining high precision are listed: no lenses between sample and plate, use of transmission samples only, use of 50 kv, use of fine-grained plates, and use of a plate measuring instrument of adequate sensitivity. For a single plate the 95% confidence limits were in the range from 0.008 to 0.014 mm. Other factors influencing precision measurements on different plates using different samples were studied. For these measurements precisions of 0.15% and 0.4% were calculated based on the worst combination of variables. (M.C.G.)

**4459** (GAT-T-1053) X-RAY FLUORESCENCE ANALYSIS FOR URANIUM IN AN ALUMINUM ALLOY MATRIX. F. J. Musil (Goodyear Atomic Corp., Portsmouth, Ohio). July 25, 1962. Contract AT(33-2)-1. 27p.

An x-ray fluorescence technique has been developed for the rapid analysis of uranium in an aluminum alloy (214X) matrix in the concentration range of about 100 to 1000 ppm U. Analysis precisions at various concentration levels were determined. The time required per determination is about 3 minutes, and about 20 minutes for 10 determinations. The sensitivity of this method is about 10 ppm U. Fluorescence analyses for uranium are being made on samples from an aluminum smelter. A single determination is made at each of five different areas on each sample. The total analysis time for each of these samples is approximately 15 minutes. (R.J.S.)

**4460** (GEAP-4082) ACCURATE NUCLEAR FUEL BURNUP ANALYSES. Third Quarterly Progress Report, June–August 1962. B. F. Rider (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 1, 1962. Contract AT(04-3)-189. 18p.

Irradiation programs were begun in MTR and VBWR to produce irradiated foils for relative fission yield and cross-section determinations. An ion exchange separation procedure for neodymium involving preferential adsorption on Dowex-1 from lithium nitrate solution is being investigated. A solvent extraction procedure for neodymium with di(2-ethyl hexyl) phosphoric acid is also being studied. In the mass spectrometry of neodymium it was found that rhenium filaments coated with carbon by heating in a butene atmosphere would reduce neodymium to the metal and prevent the formation of the less desirable $NdO^+$ ion in favor of the $Nd^+$ ion. (M.C.G.)

**4461** (JAERI-4023) ANALYTICAL CHEMISTRY OF NUCLEAR FUELS AND REACTOR MATERIALS IN JAPAN. A Bibliography. K. Motojima, H. Hashitani, and N. Saito (Japan Atomic Energy Research Inst., Tokyo). 1962. 21p.

A total of 220 references to reports is presented on analytical studies of nuclear fuels and other reactor materials in Japan, covering the period from 1958 to mid-1962. References to nine reviews are cited; the remaining references are arranged by specific materials. (R.J.S.)

**4462** X-RAY ABSORPTION-EDGE DETERMINATION OF COBALT IN COMPLEX MIXTURES. E. A. Hakkila and G. R. Waterbury (Los Alamos Scientific Lab., N. Mex.). Advan. X-Ray Anal., 5: 379-88[1962]. (TID-13406; LADC-4832)

The application of the x-ray absorption-edge technique was extended to the determination of cobalt in aqueous and alcoholic solutions containing a wide variety of impurity elements. In the procedure developed, secondary radiation from a 50% copper–nickel alloy is passed through an absorption cell filled alternately with the solvent and the sample solution. The transmitted intensities of the $K_\alpha$ lines for copper and nickel are measured, and the concentration of cobalt is determined using accepted absorption principles. The K absorption edge for cobalt occurs at 1.604 A, restricting cell construction materials and solvents to those containing light elements with low x-ray absorption characteristics and also limiting the path length of the cell. Cells of 0.16- and 0.34-cm path length were used in the analysis of aqueous and alcoholic solutions, respectively. With the 0.16-cm path-length cell, relative standard deviations of 4.6 to 0.5% were obtained for cobalt concentrations ranging from 1.00 to 10.00 mg/ml for known aqueous solutions that contain various known concentrations of nitric acid. With the longer path-length cell, relative standard deviations from 1.8 to 0.46% were obtained for cobalt concentrations in the same range in known alcoholic solutions containing various known concentrations of nitric acid. The standard deviation of determining the blank is 0.043 mg of cobalt per milliliter for the 0.16-cm cell and 0.016 mg of cobalt per milliliter for the longer cell. A Norelco x-ray spectrograph with a three-position head was used in these analyses. Less than 5 min is required to convert this instrument from normal fluorescence operation to absorption-edge analysis. Approximately 15 to 20 analyses can be performed daily. (auth)

**4463** GRAVIMETRIC METHODS FOR THE DETERMINATION OF RUTHENIUM BASED ON HYDROLYSIS. J. Brandštetr and J. Vřešťal (Technische Hochschule, Brno and Militarakademie "A. Zapotcky," Brno). Collection Czech. Chem. Commun., 27: 1798-1810(Aug. 1962). (In German)

The conditions for the precipitation of Ru(IV) hydroxide, especially by means of ammonium carbonate, and some of its properties were investigated for the purpose of defining the gravimetric determination of Ru by reduction to the metal. A method for the gravimetric determination of Ru as $RuO_2$ was also perfected. (tr-auth)

**4464** DETERMINATION OF NIOBIUM, TANTALUM, AND TITANIUM WITH 7,8-DIHYDROXY-4-METHYLCOUMARIN. V. Patrovský (Institut für Mineralische Rohstoffe, Prague). Collection Czech. Chem. Commun., 27: 1824-9(Aug. 1962). (In German)

The analytical reactions of 7,8-dihydroxy-4-methylcoumarin with metal ions were investigated. The reagent can be used instead of tannin for the precipitation and separation of Nb, Ta, and Ti. (tr-auth)

**4465** PHYSICAL METHODS OF MOISTURE MEASUREMENTS. PART 4. A. Pande (Shri Ram Inst. for Industrial Research, Delhi) and C. S. Pande. Instr. Pract., 16: 1246-51(Oct. 1962).

The neutron-scattering method of moisture determination in solids is outlined. Equipment and procedures for soils and concrete are described, and problems in calibration are discussed. The mass spectrometric method for chemical samples is described and some typical results are given. The various factors to be considered in choosing the method for moisture determination are discussed. (D.L.C.)

**4466** SOLUBILITY OF STRONTIUM SULPHATE IN WATER AND AQUEOUS SOLUTIONS OF HYDROGEN CHLORIDE, SODIUM CHLORIDE, SULPHURIC ACID AND SODIUM SULPHATE BY THE RADIOTRACER METHOD. P. J. Lucchesi and E. D. Whitney (New York Univ., New York). J. Appl. Chem. (London), 12: 277-9(1962).

Values are given for the solubility of strontium sulfate in water and in aqueous solutions of sodium chloride, sodium sulfate, hydrochloric acid, and sulfuric acid at 0° and 25°C. Determinations were made by means of a radiotracer method using a salt labeled with $Sr^{90}$ or $S^{35}$. (R.J.S.)

**4467** THE SEPARATION OF INORGANIC IONS BY ELECTROPHORESIS ON PAPER IMPREGNATED WITH ION EXCHANGERS. G. Alberti, A. Conti, G. Grassini, and M. Lederer (CNEN and CNR, Rome). J. Electroanal. Chem., 4: 301-8(Nov. 1962).

Factors influencing the movement of inorganic substances on ion exchange papers when subjected to an electric field were studied. Amberlite SA 2 paper and filter paper impregnated with zirconium phosphate were used. It is shown that various cases exist where electrophoresis on ion exchange papers presents advantages over either electrophoresis on cellulose paper or chromatography on ion exchange paper. (P.C.H.)

**4468** ACTIVATION ANALYSES OF VANADIUM, ARSENIC, MOLYBDENUM, TUNGSTEN, RHENIUM, AND GOLD IN MARINE ORGANISMS. Rinnosuke Fukai and W. Wayne Meinke (Univ. of Michigan, Ann Arbor). Limnol. Oceanog., 7: 186-200(Apr. 1962). (TID-14272)

Activation analyses were carried out for 6 trace elements — vanadium, arsenic, molybdenum, tungsten, rhenium, and gold — in the ashes of several different types of marine organisms. Radiochemical procedures coupled with gamma-ray measurement permitted unambiguous determination of submicrogram amounts of these elements. No reagent blank corrections were needed. Experimental sensitivities for each element are given. (auth)

**4469** ACTIVATION ANALYSIS OF MANGANESE AND ZINC IN SEA WATER. Elizabeth Rona (Oak Ridge Inst. Nuclear Studies, Tenn.), Donald W. Hood, Lowell Muse, and Benjamin Buglio. Limnol. Oceanog., 7: 201-6(Apr. 1962).

The use of activation analysis for the determination of microgram quantities of Mn and Zn in sea water was investigated. Total Mn and Zn were separated from the other elements of sea water by coprecipitation with iron and hydroxide, and divalent Mn and Zn were separated by extraction with diethyldithiocarbamate. Analyses were made from samples of water from different locations and depths of the North Pacific, Atlantic, and the Gulf of Mexico. Evidence indicated a substantial portion of Mn and Zn is held in sea water in a non-dialyzable and non-extractable form. (Public Health Eng. Abstr., 42: No. 11, Nov. 1962)

**4470** NEUTRON-ACTIVATION ANALYSIS. D. F. C. Morris (Brunel Coll., London). Met. Rev., 7: 241-81 (1962).

The principles of the neutron-activation analysis method and its advantages and disadvantages are outlined. The general procedure in a reactor is described, and the use of other neutron sources is also considered. Practical details of the method, e.g., sample mounting, radiochemical purification, and gamma spectrometry, are discussed. Applications of the method are described, particularly these in geochemistry and cosmochemistry and the determination of traces in pure materials. (D.L.C.)

**4471** THE SPECTROPHOTOMETRIC DETERMINATION OF THORIUM WITH ERIOCHROME BLACK T. J. Korkisch and G. E. Janauer (Univ. of Vienna). Mikrochim. Acta, No. 6, 880-3(1961). (In English)

From 0.5 to 20 μg Th/ml may be determined with Eriochrome Black T in acetate-buffered solution. Few ions interfere if the determination is performed in hydrochloric acid solution, but the lower limit is raised to 1 μg Th/ml. (auth)

**4472** DETERMINATION OF URANIUM IN HERBAGE. Nucl. Energy, 429-30(Nov. 1962).

A sample of oven-dried herbage is ignited and the ash leached with nitric acid. Uranium is extracted from the solution with tributyl phosphate/isooctane reagent and determined absorptiometrically as the dibenzoylmethane complex. (auth)

**4473** DETERMINATION OF URANIUM IN MILK. Nucl. Energy, 430-1(Nov. 1962).

A sample of milk is evaporated to dryness, ashed, and the residue dissolved in nitric acid. Uranium is extracted from the solution with tributyl phosphate/isooctane reagent and determined absorptiometrically as the dibenzoylmethane complex. (auth)

**4474** THE DETERMINATION OF SMALL CONTENTS OF ZIRCONIUM IN NATURAL MATERIALS. I. A. Tserkovnitskaya and N. S. Borovaya. Vestnik Leningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 148-50(1962). (In Russian)

The extractive variant of the mandelic method of zirconium isolation from natural materials with small contents of zirconium is discussed. (auth)

**4475** CONCENTRATING Ag, In AND Tl BY COPRECIPITATION WITH COPPER DIETHYLDITHIOCARBAMINATE. G. V. Efremov and N. I. Chaikina. Vestnik Lenigr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 151-3(1962). (In Russian)

A method of concentrating In, Tl, and Ag with copper diethyldithio carbaminate was proposed. It was determined that for complete extraction of 10 μg of the elements from 25 ml of solution, the pH should be about 6 at the moment the collector is formed, the Cu should increase 500 fold when In is concentrated, and 1500 when Ag and Tl are concentrated, and the time for precipitate ripening is 20 minutes for Tl and In, and 2 hours for Ag. (auth)

**4476** METHODS FOR THE SPECTROPHOTOMETRIC DETERMINATION OF THORIUM AND TETRAVALENT URANIUM BY MEANS OF THE AZODYE SOLOCHROME FAST GREY R.A.S. J. Korkisch and G. E. Janauer (Univ. of Vienna). Z. Anal. Chem., 182: 26-37(1961). (In English)

Two methods are described for the spectrophotometric determination of microgram amounts of thorium and tetravalent uranium in mixed solvents employing the azodye Solochrome Fast Grey R.A.S. as the photometric reagent. These two elements react with the dyestuff in hydrochloric acid and acetate-buffered methanolic solution respectively forming colored complexes which can be applied for the quantitative spectrophotometric determination of both thorium and uranous ions. 5 μg thorium or 20 μg uranium(IV)/10 ml measuring solution can be determined with a relatively high accuracy. (auth)

**4477** SPECTROPHOTOMETRIC DETERMINATION OF MICROGRAM QUANTITIES OF HEXAVALENT URANIUM. J. Korkisch and G. E. Janauer (Univ. of Vienna). Z. Anal. Chem., 183: 85-90(1961). (In English)

A method is presented for the spectrophotometric determination of microgram amounts of hexavalent uranium by means of the azodyes Monochrome Black Blue G and Diamond Black PBB, respectively. These two azodyes react with uranyl ions in an acetate-buffered hydrochloric acid-methanolic medium with formation of colored chelates. Ten or 20 μg uranium(VI)/10 ml measuring solution can be determined with relatively high accuracy. (auth)

**4478** ANION EXCHANGE SEPARATION OF URANIUM, THORIUM AND BISMUTH. J. Korkisch and F. Tera (Univ. of Vienna). Z. Anal. Chem., 186: 290-5(1962). (In English)

A method for the anion exchange separation of uranium, thorium, and bismuth is described, using the strongly basic anion exchanger Dowex 1 X8. These three elements are simultaneously adsorbed on the resin (nitrate form) from a solution consisting of 96% N propanol and 4% 5N nitric acid. The separation of thorium and bismuth from uranium is effected by washing the column with a mixture consisting of 80% methanol and 20% 5N nitric acid (elution of uranium). To separate thorium from bismuth, the resin is then treated with a solution consisting of 80% methanol and 20% 6N hydrochloric acid, whereby the thorium is eluted. Finally, the bismuth is removed by washing the column with 1N nitric acid. The experimental conditions for this separation scheme were selected after the determination of the distribution coefficients of uranium, thorium, and bismuth in different mixtures of aliphatic alcohols with nitric and hydrochloric acid. (auth)

**4479** FAST NEUTRON ACTIVATION ANALYSIS. Edgar L. Steele and W. Wayne Meinke (Univ. of Michigan, Ann Arbor). p.161-5 of "Proceedings, 1961 International Conference on Modern Trends in Activation Analysis, College Station, Texas, 1961."

Fast neutron activation analysis was investigated to determine elemental applicability, sensitivity, and shielding requirements for routine analytical operation. Neutrons were produced by a low voltage Cockcroft-Walton accelerator using the deuterium-tritium reaction. Target-life as a function of neutron yield was also studied during this investigation. Specific activities for the seven elements examined (Cr, Cu, F, Fe, N, O, and Si) ranged from $5 \times 10^5$ to $4 \times 10^4$ photopeak counts-min$^{-1}$-grams$^{-1}$ at a fast neutron flux of $10^8$ n/cm$^2$/sec$^1$. Lower limits of detection, based on 100 photopeak counts-min$^{-1}$ and a 100-g sample, ranged from 2 to 25 ppm. During irradiations, the fast neutron flux varied from $5 \times 10^8$ to $2 \times 10^7$ n/cm$^2$/sec$^1$ depending on the accelerator beam current and the condition of the metal-foil targets. Neutron flux measurements were taken continuously by monitoring the 7.4-second nitrogen-16 activity produced by the $O^{16}(n,p)N^{16}$ reaction in the target-cooling water. This system, consisting of a G-M tube, a ratemeter, and a recorder, was calibrated with standardized copper foils. Metal-foil tritium targets will produce 14+ Mev neutrons at the $10^8$ n/cm$^2$/sec$^1$ level for several hours when irradiated with 150-kev deuteride ions. Sample areas exceeding 100 cm$^3$ are available for irradiations. Shielding 14+ Mev neutrons, produced in a 150-kv Cockcroft-Walton accelerator, requires an area of 20 ft × 24 ft for a concrete block design to reduce the flux level to 10 n/cm$^2$/sec$^1$. A somewhat small design is possible with compound shielding using combinations of steel, concrete, and wax. Irradiation times, for the various reactions investigated, were selected to conserve the tritium target. With the exception of oxygen and fluorine, longer irradiation and counting times would substantially increase the sensitivity of the method. (auth)

**4480** USE OF SHORT-LIVED RADIOISOTOPES TO DETERMINE IMPURITIES IN ALUMINIUM, IRON AND ZIRCONIUM OF VERY HIGH PURITY. P. Albert, N. Deschamps, L. Fournet, and M. Deyris (Centre d'Etude de Chimie Métallurgique Vitry, France). IAEA Preprint SM-32/31. 18p. (In French)

To be published in Proceedings of the IAEA Seminar on the Practical Applications of Short-Lived Radioisotopes Produced in Small Research Reactors, Vienna, November 5-9, 1962.

The samples were irradiated with neutrons, deuterons, protons, and γ rays at 30 Mev in order to determine the amounts of oxygen, carbon, and nitrogen present. The number of elements that can be analyzed systematically after neutron irradiation is about 50, the half lives of some elements being too short; this is true, for example of $V^{52}$ (3.7 min), $Cl^{38}$ (37.5 min), $I^{128}$ (25 min), $Al^{28}$ (2.4 min), $Mg^{27}$ (9.5 min), and $Ti^{51}$ (5.8 min). There are other elements which cannot be separated and assayed with enough precision to permit systematic analysis, e.g., $Si^{28}$ with its half life of 2.8 hours, small capture cross section, and emission of $\beta^-$ radiation only. Particular attention is given to describing the assays of silicon, chlorine, bromine, and iodine, done by the classical method of radiochemical separation after neutron irradiation. The silicon is distilled in $SiF_6H_2$. Chlorine, bromine, and iodine are assayed on a single sample. The mixture of halogenides is treated with nitric acid to remove the iodine and bromine, and these two elements are carried across several absorbers by forced air flow; the bromine is fixed in a solution of sodium sulfite and the iodine is absorbed in a soda solution. The chlorine, which is not removed by the nitric acid, is precipitated as silver chloride. The methods for assaying aluminum, vanadium, magnesium, and tiranium in aluminum, iron, and zirconium are also described. In these assays, the traces of the element to be determined are separated, before irradiation, by a "nonisotopic entraining agent," and sometimes a quick radiochemical purification is carried out after irradiation. Vanadium, aluminum, and magnesium can be assayed on a single sample in the case of iron and zirconium analyses. Separation was effected by means of a "nonisotopic entraining agent" before irradiation, either because chemical separation of impurities from iron and zirconium is tedious and difficult, or because the metal to be analyzed has a very high activity during the first few minutes after irradiation (as in the case of aluminum). Gamma spectrometry was used to determine without separation vanadium and aluminum concentrations of $0.6 \times 10^{-6}$ and $2 \times 10^{-6}$, respectively, in pure iron or zirconium irradiated for 30 seconds in a flux of $5 \times 10^{12}$ n/cm$^2$/sec. Separation before irradiation is necessary if the greatest possible sensitivity is to be obtained, and also when metals of lesser purity are being dealt with. (auth)

**4481** ANALYSIS OF TANTALUM AND NIOBIUM BY NEUTRON ACTIVATION OF SHORT-LIVED RADIONUCLIDES. Chong Kuk Kim (Atomic Energy Research Inst., Seoul, Korea). IAEA Preprint SM-32/32. 9p. (In English)

To be published in Proceedings of the IAEA Seminar on the Practical Applications of Short-Lived Radioisotopes Produced in Small Research Reactors, Vienna, November 5-9, 1962.

Tantalum and niobium ores are fairly abundant in Korea, and the two ores usually occur together. No conventional type of analysis of these elements is specific enough to discriminate between them, and some other analytical method must therefore be developed. Neutron activation analysis of $Nb^{94m}$ (half life 6.6 min) and $Ta^{182m}$ (half life 16.5 min) has been carried out and found to be a fast, simple, and specific method. After irradiation, a short chemical separation is carried out, the yield of which is determined by a double tracer technique. The method enables the analysis of tantalum and niobium to be made to an accuracy of a few tenths of a microgram. (auth)

**4482** ROUTINE NEUTRON RADIOACTIVATION ANALYSIS. NON-DESTRUCTIVE ASSAY OF SODIUM, AT MEDIUM CONCENTRATIONS, IN SMALL SAMPLES OF SILICA–ALUMINA GELS AND IN SOLUTIONS. D. Barthomeuf (Institut de Recherches sur la Catalyse, Villeurbanne), P. Bussière, and J. Laverlochère. IAEA Preprint SM-32/33. 18p. (In French)

To be published in Proceedings of the IAEA Seminar on the Practical Applications of Short-Lived Radioisotopes Produced in Small Research Reactors, Vienna, November 5-9, 1962.

The results of neutron activation assay of sodium in silica–alumina gels in the range 0.1 to 3% by weight are given. A method is described whereby up to seventy samples can be irradiated together. The sodium content is obtained by $\beta$-counting with a Geiger-Mueller tube. Calibration is effected by incorporating a few standards consisting of known quantities of sodium carbonate among the unknown samples, enclosed in an irradiation tube. The activity per mg of sodium can thus be plotted against the place of each sample in the tube. This method was developed on the basis of a study which is also described of neutron flux along a file of several dozen irradiated samples. The different sources of error in activation analysis are discussed in detail. In determinations of the type described, a precision better than 3% cannot be expected. Enhancement of the stability of the detection devices should, however, permit an accuracy of 2% to be achieved. (auth)

**4483** ACTIVATION ANALYSIS WITH A TRIGA REACTOR. J. D. Buchanan (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.72-77 of "1961 International Conference on Modern Trends in Activation Analysis, A. and M. College of Texas, College Station, Texas, December 15 and 16, 1961." (GA-2662)

Some of the techniques employed in neutron activation analysis with the TRIGA reactor are presented. The prototype TRIGA Mark I and its irradiation facilities are described briefly. Sample preparation and counting are discussed. Estimated sensitivities for irradiation in the TRIGA flux of $1.8 \times 10^{12}$ n/cm$^2$/sec for 1 hr or less are tabulated for 67 elements. Some applications of activation analysis with TRIGA include analyses of agricultural products for inorganic elements, of inorganics for impurities, and of biological materials for trace elements. (D.L.C.)

**4484** RADIOACTIVATION ANALYSIS—SPECIFIC FOR TRACE ELEMENT DETERMINATIONS. G. W. Leddicotte (Oak Ridge National Lab., Tenn.). p.21-43 of "Symposium on Extension of Sensitivity for Determining Various Constituents in Metals." Special Technical Publication No. 308. Philadelphia, American Society for Testing and Materials, 1961.

Nuclear technology developments concerned with the interpretation of nuclear particle production processes and the measurement of the resulting end products of the interactions of these particles with matter have made it possible to create very sensitive and specific analytical methods based on radioactivation analysis. Nuclear particle, particularly neutron, outputs from both accelerators and reactors that can be used in this analysis method are sufficiently intense to make it possible to determine very small amounts of most elements in many different types of sample materials. In effect, in a radioactivation analysis, the radioactivity of the radioisotope induced into a stable isotope of the element during a nuclear particle irradiation becomes a "fingerprint" of that stable isotope, and a measurement of its intensity makes it possible to determine quantitatively the concentration of the stable isotope in a sample. A number of investigators routinely use radioactivation analysis in trace impurity problems. In many of these applications, limits of measurement much more sensitive than those possible by more conventional analytical methods have been obtained. Also, it has been observed that the half life and the radiations emitted by a particular radionuclide being used as the "fingerprint" are never exactly duplicated by any other radionuclide; thus, radioactivation analysis is a very specific method. It is also extremely free of the contamination difficulties experienced in other analytical methods unless the contamination has been introduced into the sample before the start of the nuclear particle irradiation. The most used method is that of neutron radioactivation. At Oak Ridge National Laboratory, neutron radioactivation analysis has been used to determine microgram and submicrogram amounts of almost all of the elements in many different sample materials. Certain neutron radioactivation analysis applications used in the determination of trace elements in metals are described. Information about multisample handling techniques, irradiation methods, processing of irradiated sample materials, and radioactivity measurements by means of gamma spectrometry employed in these applications are given. Typical data obtained in the analysis of high-purity metals such as silicon, titanium, bismuth, zirconium, aluminum, and niobium are reported. Some speculations about the use of commercially available irradiation equipment in routine activation analysis problems in the metals industry are given. (auth)

**4485** URANIUM. Glenn L. Booman and James E. Rein (Phillips Petroleum Co., Idaho Falls, Idaho). p.1-188 of "Treatise on Analytical Chemistry." I. M. Kolthoff and Philip J. Elving, eds. New York-London, Interscience Publishers, [1960].

A literature review is presented on uranium chemistry. The occurrence of uranium and its preparation in industry are described briefly. The basic chemistry of uranium and its properties affecting its analysis are discussed. Dissolution of samples containing uranium is considered, and methods for the separation, detection, and determination of uranium are discussed in detail. Methods for determining the isotopic distribution of uranium are next discussed. Finally, recommended procedures for the determination of uranium are given. (D.L.C.)

**4486** PART I. THE STEPWISE TITRATION OF Fe(III) AND Fe(II) WITH EDTA AND FERRICYANIDE. THE SQUARE WAVE TITRIMETRIC END POINT. PART II. THE POLAROGRAPHY OF RARE EARTH METAL IONS IN ANHYDROUS ETHYLENEDIAMINE. David Addison Flanigan. Thesis, Nashville, Vanderbilt Univ., 1962. 120p.

Mixtures of Fe(III) and Fe(II) were successfully titrated by a square wave titrimetric procedure. The method developed involves the application of a small square wave a-c potential of low frequency to a pair of identical platinum electrodes in a solution of Fe(III) and Fe(II) and the measurement of the a-c square wave current. The measurement of current will give a direct indication of the slope of the current voltage polarization curve of the Fe(III)-Fe(II) couple at the equilibrium potential. Examination of the Fe(III)-EDTA and Fe(II)-EDTA stability constants indicated that at low pH Fe(III) can be titrated with no interference from Fe(II), and that by subsequently raising the pH, Fe(II) can be titrated. A mixture of Fe(III) and Fe(II) was buffered at a pH of 5 with either glycene or acetate. Initially a large current flowed due to the presence of the reversible Fe(III)-Fe(II) couple. Upon the addition of EDTA the Fe(III) was complexed and the current began to decrease until a minimum was reached, when all the Fe(III) was complexed and no reversible couple was present. On further addition of EDTA, the Fe(II) was complexed and an increase in current resulted, owing to the presence of the Fe(III)EDTA-Fe(II) EDTA reversible couple. Thus, a V-shaped end point was obtained for the titration of Fe(III). Enough EDTA was then added to completely complex the Fe(II). The resulting Fe(II)-EDTA was then titrated with potassium ferricyanide. The oxidation of the Fe(II)-EDTA resulted in a decrease in the current flow until all the Fe(II)-EDTA was titrated. The first excess amount of ferricyanide added resulted in a current increase owing to the presence of the ferrocyanide-ferricyanide reversible couple. Thus, in the titration of Fe(II)-EDTA with ferricyanide, a V-shaped end point again resulted. The polarography of lanthanum, praseodymium, and ytterbium acetates in anhydrous ethylenediamine was also studied. The reference electrode used was $Zn(Hg)/ZnCl_2$. In contradiction to published results it was shown that anhydrous rare earth acetates may be prepared by dissolution of the rare earth oxide in dilute acetic acid, followed by evaporation and drying at 150°. Only one reduction wave was obtained for anhydrous lanthanum acetate in anhydrous ethylenediamine. The wave has a half-wave potential of -0.571v vs $Zn(Hg)/ZnCl_2$ and was totally irreversible. Micro-coulometric measurements indicated that the value for n was 3. In the case of praseodymium acetate in ethylenediamine, one wave was observed. The wave was totally irreversible and exhibited a half-wave potential of -0.565v vs Zn. The number of electrons exchanged in the reduction step was determined by pilot ion coulometry to be 3. Ytterbium acetate exhibited two reduction waves in anhydrous ethylenediamine. The first wave had a half-wave potential of -0.411v vs the Zn electrode. The second wave was twice as high as the first one and exhibited a half-wave potential of -0.747v vs Zn. Both waves were totally irreversible. The pilot ion coulometric measurements indicated that the first wave was one electron reduction to the divalent state and that the second wave was a two electron reduction of the divalent ion to the amalgam. (Dissertation Abstr., 23: No. 4, 1962)

**4487** SPECTROGRAPHIC ANALYSIS APPARATUS AND PROCESS. Maurice Stephen William Webb, Robert John Webb, and Peter Charles Wildy (to United Kingdom Atomic Energy Authority). British Patent 900,423. July 4, 1962.

An apparatus and a process for the direct spectrographic measurement of small amounts of selected elements in a gas are described with particular reference to the determination of beryllium in the atmosphere. The air to be sampled is drawn through a specially designed chamber, and the beryllium is optically excited as it passes through an intermittent a-c arc. The radiation from this source is resolved by means of a small spectrograph, and the intensity of the line characteristic of beryllium is measured relative to that of the adjacent background and the ratio recorded on a chart. Provision is made for the automatic calibration of the process, and the sensitivity is unaffected by the chemical form of the beryllium entering the monitor or by the size of particles normally present in atmospheric dust.

**4488** MEANS FOR THE QUANTITATIVE ANALYSIS OF DEUTERIUM IN HYDROGEN-CONTAINING COMPOUNDS. Guy Nief and Rene Botter (to Commissariat à l'Énergie Atomique). U. S. Patent 3,066,220. "Priority date Aug. 30, 1958 France."

Deuterium in hydrogen-containing compounds is quantitatively analyzed using a mass spectrometer which separates ions having an atomic mass of two from ions having an atomic mass of three. The hydrogen-containing compounds are reduced in a uranium reduction oven in order that the hydrogen and deuterium will appear in the free gaseous state. (R.J.S.)

## Inorganic and Physical Chemistry

*Refer also to abstract 5063.*

**4489** (GAT-T-1051) THE PRECISE AND ACCURATE DETERMINATION OF THE LATTICE PARAMETER OF SILICON USING THE LIKELIHOOD RATIO METHOD. Karl E. Beu, Frank J. Musil, and D. Ransom Whitney (Goodyear Atomic Corp., Portsmouth, Ohio). July 13, 1962. Contract [AT(33-2)-1]. 8p.

The Likelihood Ratio Method was used to determine the lattice parameters of silicon. The method is described and the results are compared with values previously obtained. (R.J.S.)

**4490** (GAT-T-1052) THE LIKELIHOOD RATIO METHOD FOR THE PRECISE AND ACCURATE DETERMINATION OF LATTICE PARAMETERS. K. E. Beu, F. J. Musil, and D. R. Whitney (Goodyear Atomic Corp., Portsmouth, Ohio). July 13, 1962. Contract [AT(33-2)-1]. 10p.

The Likelihood Ratio Method (LRM) provides a valid statistical criterion for determining the accuracy of lattice parameter data based on the premise of internal self-consistency of the data; i.e., a lattice parameter of a given sample is the same regardless of which (hkl) reflection is used to calculate this parameter. The LRM can also be useful in pinpointing the sources of systematic error and in evaluating the techniques used in correcting for systematic errors. (R.J.S.)

**4491** (HW-SA-2641) PARTICULATES GENERATED DURING THE AIR OXIDATION OF URANIUM. L. F. Coleman and L. C. Schwendiman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 21, 1962. Contract AT(45-1)-1350. 26p.

The effect of temperature on the nature of oxide formed from uranium oxidizing in air is pronounced, there being an increase in particle size with increasing temperature over the range 400 to 800°C. At 1000°C and above the oxide formed remains largely intact, giving rise to few-micron size particles during the heating period. In relating these facts to fission product release, it would be anticipated that the effect of air velocity on the release of fission products would be more pronounced at lower temperatures. Only a fraction of those oxide particles of apparent entrainable size become airborne, emphasizing the possible effects of fuel element geometry and orientation. This stability of a mass of fine particles is an important factor to consider in a system where localized high air velocities or explosions might occur. This material once dispersed by a sudden rise in air stream velocity could remain suspended for extended periods of time. Deposition of uranium oxide and fission products on experimental apparatus points out the importance of the location of the fuel element during an overheating incident. In conclusion, particulate entrainment and deposition, fuel element geometry, orientation, and location are variables which may have an important effect on fission product release. These variables along with effects of temperature, fuel element composition, cladding, air velocities, and irradiation level compose a very complex system. Since little research to date has dealt with deposition parameters, this area merits added consideration. (auth)

**4492** (IDO-14597) THERMAL DECOMPOSITION OF HYDRATED IRON, CHROMIUM, AND NICKEL NITRATES AND THEIR MIXTURES. E. M. Vander Wall (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Nov. 26, 1962. Contract AT(10-1)-205. 23p.

The thermal decomposition of ferric nitrate nonahydrate, chromium nitrate nonahydrate, aluminum nitrate nonahydrate, and nickel nitrate hexahydrate as well as the mixtures of these compounds in the proportions produced in the dissolution of Nichrome and stainless steel alloys was investigated. The experiments were conducted in air at two heating rates, approximately 1.1°C and 2.6°C per minute. The intermediate products and final products were analyzed by x-ray diffraction and chemically where it was appropriate. (auth)

**4493** (LAMS-2762) DIGITAL PROGRAMS FOR PARA HYDROGEN PROPERTIES. O. A. Farmer (Los Alamos Scientific Lab., N. Mex.). Sept. 14, 1962. Contract W-7405-eng-36. 34p.

Programs for computing para-hydrogen properties from inputs of temperature and pressure were written. The range is 20 to 3000°K and 1 to 100 atm. The programs are written as closed fortran subroutines to be used on the IBM-7090. The equations, references, graphs, and tabular values are given. (auth)

**4494** (SCR-512) ISOTOPIC EXCHANGE REACTIONS (UNCLASSIFIED REFERENCES). Milton Kahn, Kenneth R. Applegate, and Bruce Erdal (New Mexico. Univ., Albuquerque). May 1962. For Sandia Corp., Albuquerque, N. Mex. 104p.

A compilation of 995 references to unclassified work on isotopic exchange reactions listed in *Chemical Abstracts* and *Nuclear Science Abstracts*, 1950 to 1959 inclusive, is presented. Only those studies which employed radioisotopes are included. The listings are arranged alphabetically by author. A subject index is included. (M.C.G.)

**4495** (TID-13772) DIFFERENTIAL THERMAL ANALYSIS OF THE DECOMPOSITION OF SODIUM BICARBONATE, TRONA, AND WEGSCHEIDER'S SALT. Edward M. Barrall, II and L. B. Rogers (Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry and Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Sept. 13, 1961. Contract AT(30-1)-905. 20p.

The thermal decompositions of sodium bicarbonate, trona, and Wegscheider's salt were studied in a closed system by means of differential thermal analysis and x-ray diffraction analyses. The energies of activation and empirical orders of the thermal decompositions of these materials were calculated from the differential thermograms using Kissinger's equations. The decomposition products of trona, sodium bicarbonate, and Wegscheider's salt were identified by x-ray diffraction. A reaction sequence involving the formation of Wegscheider's salt is proposed to explain the thermal anomalies previously observed in the decomposition of sodium bicarbonate in a closed system. (auth)

**4496** (TID-17367) THERMODYNAMIC PROPERTIES OF FUSED SALTS. Final Report. Douglas G. Hill and John M. Chamberlin (Duke Univ., Durham, N. C.). [1962]. Contract AT(40-1)-2479. 29p.

Experiments were performed to determine the effect of fluoride as a complexing agent in fused salts, using recent polarographic and potentiometric methods. A number of solvents were tried, including nitrates, nitrites, acetates, perchlorates, and chlorides. (R.J.S.)

**4497** (UCRL-10451) MATRIX ISOLATION STUDIES OF HIGH-TEMPERATURE SPECIES GROUP II CHLORIDES (thesis). Raymond W. McNamee, Jr. (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 13, 1962. Contract W-7405-eng-48. 76p.

A matrix isolation technique for the investigation of infrared absorption spectra of molecules of high-temperature species trapped in a "pseudo-gas phase" is described. The spectra of the dichlorides of zinc, cadmium, and mercury in argon, krypton, and xenon matrices are reported. Presence in the gas phase of dimers of zinc chloride and mercuric chloride is noted. An absorption band, previously reported as due to the degenerate bending motion of zinc chloride, is attributed to zinc dimer. (auth)

**4498** (UCRL-10460) CONFIGURATION INTERACTION IN THE RARE EARTHS AND ITS EFFECT ON THE STARK LEVELS OF $PrCl_3$ AND $GdCl_3 \cdot 6H_2O$ (thesis). Katheryn Edmonds Rajnak (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1962. Contract W-7405-eng-48. 118p.

The techniques of Racah were used to obtain expressions for the matrix elements of the Coulomb interaction between the configuration $4f^2$ and the excited configurations 4f6p and 4f5f, and between $4f^7$ and $4f^6 6p$. Approximate SCF radial wave functions were computed for $Pr^{+3}$ and $Tm^{+3}$ and used to calculate the necessary radial integrals. A second-order crystal field interaction between the configurations $4f^2$ and 4f5d was also considered. While these mechanisms lead to rather large shifts in some of the Stark levels of $Pr^{+3}$ in

$PrCl_3$, no one mechanism gives shifts large enough to explain the observed discrepancy between the experimental levels of the $^1D_2$ and those calculated by Margolis. The interaction of $4f^7$ with $4f^66p$ is not large enough to explain the splitting of the $^1P_{1/2}$ and $^6P_{1/2}$ levels of $GdCl_3 \cdot 6H_2O$ observed by Dieke and Leopold. (auth)

**4499** (UCRL-10482) A MOLECULAR-BEAM ELECTRIC-RESONANCE SPECTROMETER AND THE RADIO-FREQUENCY SPECTRA OF LITHIUM FLUORIDE (thesis). Alvin Joseph Hebert (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 26, 1962. Contract W-7405-eng-48. 86p.

The construction and operation of a radio-frequency electric resonance molecular beam apparatus are described. The resolution of the apparatus is consistent with theoretical expectations. A mass spectrograph and an automated counting-recording scheme allow the procurement of spectra from signals that correspond to as few as one hundred detected transitions per second. The experimental results obtained for lithium fluoride are presented and discussed. Spectra were observed for the first three vibrational states of $Li^6F^{19}$ and $Li^7F^{19}$. A value for the lithium quadrupole coupling constant, the spin-rotation constant, the Stark-effect constant, and the dipole moment is reported for each vibrational state. Results for the V = 2 vibrational state of $Li^7F^{19}$ are reported. An analysis of the $Li^7F^{19}$ spectra resolved an uncertainty in the rotational and vibrational constants previously reported. This in turn allowed a much more accurate determination of the dipole moments of LiF. (auth)

**4500** (AEC-tr-5529) ADSORPTION OF ELECTROLYTES ON ZIRCONIUM OXIDE AFTER ACTIVATED ADSORPTION OF HYDROGEN ON IT. L. G. Maidanovskaya, E. F. Filatova, and M. V. Kalinova. Translated for Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh from Uch. Zap. Tomsk. Gos. Univ., No. 29, 37-41 (1959). 6p.

The adsorption of hydrogen on $ZrO_2$ in the temperature range from 50 to 750°C with an initial hydrogen pressure of 0.808 mm Hg was investigated. It was found that there is activated adsorption of hydrogen at 1755 to 550°C. Partial reduction of $ZrO_2$ to $Zr_2O_3$ was observed at 550°C. A study was made of the adsorption of Na, K, and Ba cations from aqueous solutions of the chlorides on $ZrO_2$ and on $ZrO_2$ that had first adsorbed hydrogen in the temperature range of activated adsorption. In the first case there was an increase in the acidity of the solution and in the second case this increase in acidity was much less. A possible mechanism for the process is discussed. (auth)

**4501** THERMODYNAMIC PROPERTIES OF Zr AND Hf HALIDES. S. N. Lungu (Inst. of Nuclear Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 29-35(1962). (In Rumanian)

The following standard heats of formation were found: $ZrCl_3$, 178.6 ± 3.2; $ZrCl_2$, 124.3 ± 3; $ZrBr_3$, 151 ± 7; $ZrBr_2$, 100 ± 6; $ZrI_3$, 103 ± 6; $ZrI_2$, 68 ± 4; and $HfCl_4$, 239.4 ± 5.5; $HfCl_3$, 186.6; $HfCl_2$, 130; $HfBr_4$, 200; $HfBr_3$, 157; $HfBr_2$, 108; $HfI_4$, 140; $HfI_3$, 113; and $HfI_2$, 72 kcal/mole. (R.V.J.)

**4502** THE CRYSTAL STRUCTURE OF LITHIUM FLUOROANTIMONATE(V). John H. Burns (Oak Ridge National Lab., Tenn.). Acta Cryst., 15: 1098-1101(Nov. 10, 1962).

The crystal structure of $LiSbF_6$ has been determined by single-crystal counting techniques and least-squares refinement. The unit cell is rhombohedral, $R\bar{3}$, with a = 5.43 Å, $\alpha = 56° 58'$ and contains one formula weight. The fluorine atoms form regular octahedra about the antimony and about the lithium atoms at distances of 1.88 ± 0.02 and 2.03 ± 0.02 Å, respectively. The structure may be described as a rhombohedral distortion of the cubic $NaSbF_6$ arrangement. (auth)

**4503** A GEOMETRICAL RELATIONSHIP BETWEEN $UC_2$(TETRAGONAL) AND $U_2C_3$(CUBIC). E. Gillam (General Electric Co Ltd., Wembley, Eng.). Acta Cryst., 15: 1183-4(Nov. 10, 1962).

The positions of the uranium atoms are considered in $UC_2$ and $U_2C_3$. These atoms determine the framework of the two structures, the carbon atoms diffusing during transformation to new positions and forming the stoichiometric relationship. This transformation can be regarded as one in which there is little or no interchange in the positions of neighboring uranium atoms, a feature normally regarded as characteristic of martensitic transformations. (R.J.S.)

**4504** THE CRYSTAL STRUCTURE OF TETRAGONAL $ZrO_2$. G. Teufer (E. I. du Pont de Nemours and Co., Wilmington, Del.). Acta Cryst., 15: 1187(Nov. 10, 1962).

In the course of a high-temperature x-ray diffraction study of tetragonal $ZrO_2$, a number of previously unreported reflections, which are inconsistent with a body-centered lattice, have been observed. The intensities of most of these reflections are rather low, but the strongest of these (the (102) reflection) was observed throughout the temperature range from 1200 to 1950°C. during heating and from 1950 to 900°C. during cooling, both in purified $ZrO_2$ as well as in specimens containing about 2% of hafnium. (R.J.S.)

**4505** UNIT CELL AND SPACE GROUP OF $2Nb_2O_5-Ta_2O_5$. Ganesh P. Mohanty, Leon J. Fiegel, and James H. Healy (A. O. Smith Corp., Milwaukee). Acta Cryst., 15: 1190(Nov. 10, 1962).

Diffraction studies of single $Nb_2O_5-32\%\ Ta_2O_5$ crystals established the unit cell as body centered. Cell dimensions are: a = 15.77 ± 0.01 Å, c = 3.84 ± 0.01 Å. Powder studies resulted in determination of an approximate density of 6.10 $g/cm^3$. A possible space group was determined from diffraction symmetry and systematic absences. (R.J.S.)

**4506** THE OXIDIZED COMPLEX OF NICKEL WITH 4-CARBOXY-1, 2-CYCLOHEXANEDIONEDIOXIME IN ALKALINE MEDIA. Charles V. Banks and J. P. LaPlante (Ames Lab., Ames, Iowa). Anal. Chim. Acta, 27: 101-12 (1962). (IS-324)

The reaction of oxygen with a nickel(II) complex of 4-carboxy-1,2-cyclohexanedionedioxime in alkaline media was studied spectrophotometrically, polarographically, and by spectrophotometric titrations with tin(II) chloride. Magnetic susceptibility measurements were also performed. The rate of formation of the oxidized complex was found to be first order at 25 and 50°. The average values obtained for the rate constant $k_1'$ are $2.71 \pm 0.23 \times 10^{-2}\ h^{-1}$ (25°), spectrophotometrically; $5.99 \pm 0.83 \times 10^{-2}\ h^{-1}$ (50°), polarographically; $4.98 \pm 0.90 \times 10^{-2}\ h^{-1}$ (50°), titrimetrically; $2.87 \pm 0.29 \times 10^{-2}\ h^{-1}$ (50°), curve fitting. The value obtained for the rate constant $k_2'$ is $1.59 \pm 0.16 \times 10^{-2}\ h^{-1}$ (50°), curve fitting. The effect of reducing agents on the formation of the oxidized complex was studied. It was found that tin(II) chloride, hydrazine sulfate, and hydroxylammonium chloride prevented the formation of the oxidized complex. A reaction mechanism for the formation and decomposition of the oxidized complex is proposed. (auth)

**4507** REVERSIBLE AND IRREVERSIBLE PROCESSES IN THE DROPPING MERCURY ELECTRODE. XIII. $Nd^{+3}$, $Gd^{+3}$, $Tb^{+3}$, $Ho^{+3}$, $Er^{+3}$, $Tm^{+3}$, AND $Lu^{+3}$. J. Almagro, V. Almagro, and J. Sahcho (Instituto A. de G. Rocasolano, del C. S. de I. C. Murcia, Spain). Anales Real Soc. Espan.

Fis. Quim. (Madrid), Ser. B, 58: 459-68(June 1962). (In Spanish)

A polarographic study of these ions is carried out in support solutions of 0.1 M LiCl, 0.1% gelatin, and in 25, 50, and 75% ethyl alcohol. Only one wave has been observed corresponding to a process $M^{+3}3e^- = M^0$, which has been verified in all elements by means of the respective micro-coulombimetric study. The observed waves are well defined and useful for analytical studies, wherefore the corrected potentials and the values of the diffusion current constant have been given. These waves have also been studied for different conditions of pH and temperature. These elements have been studied by derivative polarography and it has been proved that the variations in wave heights and concentrations are strictly linear between $1 \times 10^{-3}$ and $3 \times 10^{-3}$ M, this method being also of interest for discussing the reduction mechanism of the ions mentioned. (auth)

**4508** THE ABSORPTION SPECTRUM OF DBr IN THE VACUUM ULTRAVIOLET REGION. J. G. Stamper (National Research Council, Ottawa). Can. J. Phys., 40: 1279-93(Oct. 1962). (NRC-6996)

The absorption spectrum of DBr has been photographed under high dispersion in the vacuum ultraviolet region. More than 30 bands have been observed and rotational analyses have been obtained for most of them. As in the case for HBr, little regularity is to be found among the various bands and the relationship between the spectra of the two isotopic species is frequently unclear. It has therefore not proved possible to arrive at any detailed conclusions as to the nature of the upper states of the bands. (auth)

**4509** THE ANGULAR DISTRIBUTION OF $\gamma$-RAYS FROM $Mn^{54}$ ORIENTED IN ANTIFERROMAGNETIC $CoCl_2 \cdot 6H_2O$. J. M. Daniels (Univ. of Toronto) and D. J. Griffiths. Can. J. Phys., 40: 1332-41(Oct. 1962).

The angular distribution of $\gamma$-rays from $Mn^{54}$ nuclei, included as an impurity in antiferromagnetic $CoCl_2 \cdot 6H_2O$, was measured at temperatures between 0.03°K and 0.18°K. Three $\gamma$-ray counters were placed, one each along the crystallographic a, b, and c axes, and the angular distribution was analyzed into a series of spherical harmonics. The aspheric component of the $\gamma$-ray distribution was found to be proportional to $(3 \cos^2\theta - 1) + 2.6 \sqrt{3} \sin^2\theta \cos 2\phi$, where $\theta$ and $\phi$ are polar co-ordinates; the polar axis is the crystallographic b axis, and the origin of $\phi$ is 46° from the a axis in the obtuse angle between the a and c axes. This result is discussed in terms of present knowledge of the antiferromagnetic ground state configuration of $CoCl_2 \cdot 6H_2O$ and of present ideas of the mechanism of nuclear alignment in antiferromagnetic materials, but no satisfactory explanation is found. (auth)

**4510** NUCLEAR ORIENTATION OF $Mn^{54}$ IN $MnSiF_6 \cdot 6H_2O$. J. M. Daniels and D. J. Griffiths (Univ. of British Columbia, Vancouver). Can. J. Phys., 40: 1417-22(Oct. 1962).

$Mn^{54}$ was oriented in a single crystal of $MnSiF_6 \cdot 6H_2O$, and the anisotropy of emission of $\gamma$-rays relative to the trigonal axis of the crystal was measured as a function of temperature in the range 0.06°K to 0.12°K. The anisotropy exhibited the expected $1/T^3$ dependence in this temperature range. From these measurements, a value of $-0.034 \pm 0.005$ $cm^{-1}$ was deduced for the value of the constant D which occurs in the spin-Hamiltonian $g\beta H \cdot S + D\{S_z^2 - \frac{1}{3}S(S + 1)\} + AS \cdot I$. (auth)

**4511** THE PHYSICAL CHEMISTRY OF ISOTOPIC SUBSTANCES. THE EFFECT OF PHYSICAL CHANGES ON ISOTOPE FRACTIONATION. T. C. Hoering. THE CARBON ISOTOPE EFFECT IN THE SYNTHESIS OF DIAMOND. T. C. Hoering. THE ISOTOPE EFFECT IN THE LOW-TEMPERATURE ADSORPTION OF GASES. T. C. Hoering and M. Bufalini. Carnegie Inst. Wash., Papers Geophys. Lab., No. 1363, 201-7(Dec. 11, 1961).

Measurements were made on the isotope effect in the solution of $CO_2$ in water, the effect of varying the activity coefficients of $H_2O^{18}$ and $H_2O^{16}$, the effect of pressure on isotope fractionation, and the temperature coefficient of an isotope effect. The results indicated that pressure is not an important variable in determining the isotopic composition of substances. In the investigation of the carbon isotope effect in the synthesis of diamond at a temperature higher than 1700°C, fractionation between the graphite and diamond phases measured only 0.3% mil difference in the $C^{13}/C^{12}$ ratio. Therefore, it appears that there is little, if any, effect of pressure at such a high temperature. The isotope fractionation factor for several gases adsorbed on different adsorbents at low temperatures was also measured. For systems studied at two different temperatures there was very little, if any, temperature effect between 74 and 193°K. A lack of temperature and pressure effects was found for the adsorption of nitrogen on charcoal. (P.C.H.)

**4512** UNIVERSITY OF CALIFORNIA RADIATION LAB. MELTS URANIUM HYDRIDE. John F. Lakner (Univ. of California, Livermore). Chem. Eng. News, 39: 39 (Nov. 27, 1961). (UCRL-6656)

The melting range of uranium hydride ($UH_3$) was found to be between 1005 and 1085°C under a hydrogen pressure of approximately 8500 psi. A pressure vessel fitted with an internal heater served as the apparatus. The heater was made by winding molybdenum wire onto pure $Al_2O_3$ tubing. All voids were filled with ceramic material to reduce convection currents. Mo-MoRe and Ni-NiCr couples measured the temperature of the melt and both were found to be satisfactory. (P.C.H.)

**4513** SELF-DIFFUSION IN MOLTEN ALKALI HALIDES. J. O'M. Bockris and G. W. Hooper (Univ. of Pennsylvania, Philadelphia). Discussions Faraday Soc., No. 32, 218-36(1962).

A new method for the measurement of self-diffusion coefficients in molten salts is described. Determinations of $D_i$ for i = $Na^+$ and $Cl^-$ in NaCl; $Rb^+$ and $Cl^-$ in RbCl; $Cs^+$ and $Cl^-$ in CsCl; and $Na^+$ and $I^-$ in NaI as a function of temperature, are reported. The heats of activation for self-diffusion of cations and anions in the same salts are almost equal and in the range 4 to 8 kcal $mole^{-1}$. The pre-exponential factors in $D = A \exp - E/RT$ are about $10^{-3}$ $cm^2$ $sec^{-1}$. The D values are about $10^4$ greater than those in the corresponding solid at the melting point. The ratio of $D_{cat}/D_{an.}$ is about the same as in the solid at the mp. The results yield friction coefficients on the basis of an electrolyte consisting of two ions with no uncharged reference species; these show trends in which physical consistence is unclear. Sources of deviation from the Nernst-Einstein equation are summarized. If the principal cause of deviation is attributed to a non-charge transporting mode of transport, activation energies are obtained for charge-carrying transport which are consistent (±0.2 kcal $mole^{-1}$) with those experimentally determined for electrical conductance; derived D are consistent with other tests of the approximation. The mean observed heat of activation is 3.5 $RT_{mp}$, which is the theoretical value expected if the diffusive movements are jumps into thermally distributed holes. Calculations of the pre-exponential factor are consistent with the coupled requirements of entropy of activation and activation volume. They support transport by ion-diameter jumps into ion-sized holes. (auth)

**4514** THE KINETICS AND MECHANISMS OF CARBON DEPOSITION DURING GASEOUS PYROLYSES. Howard B. Palmer (Pennsylvania State Univ., University Park). Fuel Soc. J., Univ. Sheffield, 13: 7-18(1962).

An evaluation is presented of the state of knowledge concerning the mechanisms of carbon deposition during oxygen-free hydrocarbon pyrolyses. The evidence indicates that the temperatures above about 1000°K, $C_2H_2$ is an intermediate in most carbon-forming systems but the last, relatively stable precursor of carbon is diacetylene. Vinylacetylene (formed from acetylene) plays a significant role in explaining some of the experimental observations. The case of carbon formation from benzene is accounted for by the large yield of diacetylene in benzene pyrolysis. Well-controlled studies of carbon deposition kinetics have been few in number. A review of these shows that in most of them, the deposition rate has been controlled by the rate of some gas-phase process, usually a chemical decomposition rate. (auth)

**4515** CORRECTIONS FOR THE VAPOR PRESSURE OF METALLIC YTTRIUM. V. V. Karelin, A. N. Nesmeyanov, and Yu. A. Priselkov. Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk, Met. i Toplivo, No. 5, 117-18(Sept.-Oct. 1962). (In Russian)

Data are given on the vapor pressure of yttrium containing only traces of metallic and <0.1% gaseous admixtures. The measurements are tabulated and the equation, lg P mm Hg = 8.0786 – (18515/T) (1405 to 1733°K), was derived by the method of least squares. The heat of sublimation was found at 84.71 kcal/g atom. The order of error was ±20% for radioactive specimens and ±24% for non-radioactive. (R.V.J.)

**4516** COLLOID AND SURFACE CHEMISTRY IN THE MAINSTREAM OF MODERN CHEMISTRY. Robert S. Hansen and C. A. Smolders (Iowa State Univ., Ames). J. Chem. Educ., 39: 167-78(Apr. 1962). (IS-393)

A review is presented on the developments in colloid and surface chemistry. The review is divided into three sections dealing with (1) problems of 30 years ago which are now solved (interactions of molecules with solids at a distance, lyophilic colloids, and lyophobic sols), (2) unsolved problems now being studied with results (first adsorbed layer, electrochemical reactions, and wetting process), and (3) unsolved problems needing new research approaches (physical adsorption from solution in the monolayer region, mechanical properties of surface films, and foams and emulsions). (D.L.C.)

**4517** SOLUBILITIES OF $LiBH_4$ AND LiH IN DIETHYL ETHER. D. A. Brandreth and M. C. Molstad (Univ. of Pennsylvania, Philadelphia). J. Chem. Eng. Data, 7: 449-50(Oct. 1962).

The solubility of $LiBH_4$ in anhydrous diethyl ether was measured at 1.0 to 38.8°C; it ranged from 1.37 g at 1.0°C to 28.5 g at 38.8°C per 100 g ether. The solubility of LiH in diethyl ether at room temperature was found to be less than the sensitivity of the test (0.05 ppm). (D.L.C.)

**4518** HIGH TEMPERATURE PHASE EQUILIBRIA IN THE SYSTEM CARBON–OXYGEN–URANIUM. J. R. Piazza and M. J. Sinnott (Univ. of Michigan, Ann Arbor). J. Chem. Eng. Data, 7: 451-7(Oct. 1962).

Studies were carried out on phase relations involving U carbides, $UO_2$, and graphite. Two univariant equilibria were found at 1714 to 1953°K: $UO_2 + 4C \rightarrow UC_2 + 2CO$ and $UO_2 + 3UC_2 \rightarrow 4UC + 2CO$. Equilibrium CO pressures for the two equilibria were found to be $\log_{10}p = -18{,}000/T + 8.23$ and $-16{,}000/T + 7.26$, respectively. The effects of $N_2$ on the equilibria were studied and are used to predict certain features of the C–N–O–U phase diagram. The standard Gibbs free energies of formation for UC and $UC_2$ were calculated and compared with these reported by Grieveson. (D.L.C.)

**4519** PHASE TRANSFORMATION OF ZIRCONIUM OXIDE. INFLUENCE OF PRESSURE AND TEMPERATURE. F. W. Vahldiek, L. B. Robinson, and C. T. Lynch (Wright-Patterson Air Force Base, Ohio). J. Chem. Eng. Data, 7: 479-(Oct. 1962).

Monoclinic zirconia was pressed to ~20,000 atm at >1800°C, quenched, fired for 1 hr at 1350°C, and quenched. X-ray diffraction patterns were obtained while quenching was repeated through the phase transformation temperature range 800 to 1240°C; the results show that the new monoclinic-tetragonal phase transformation is shifted to 950 to 1000°C and that the tetragonal phase is stabilized at low temperatures. (D.L.C.)

**4520** SOLUBILITY OF LITHIUM HYDROXIDE IN WATER AND VAPOR PRESSURE OF SOLUTIONS ABOVE 220°F. Elmer F. Stephan and Paul D. Miller (Battelle Memorial Inst., Columbus, Ohio). J. Chem. Eng. Data, 7: 501-5(Oct. 1962).

The solubility of $LiOH \cdot H_2O$ in water was measured at 220 to 650°F. The solubility curve showed a maximum of ~18 g/100 g $H_2O$ at 240°F and a minimum of ~13 g/100 g $H_2O$ at 480°F. Vapor pressures at temperatures up to 700°C were measured for a saturated LiOH solution and for solutions containing 5 and 9.4 g LiOH/100 g $H_2O$. The vapor pressure depressions are compared with these of NaOH solutions. (D.L.C.)

**4521** THERMODYNAMIC PROPERTIES OF URANIUM GAS. W. B. Kendall (Univ. of California, Berkeley). J. Chem. Eng. Data, 7: 540(Oct. 1962).

A complete set of thermodynamic properties for uranium gas was calculated from the energy levels in the optical spectrum. The properties are tabulated for temperatures from 298.15 to 5000°F. (D.L.C.)

**4522** LITHIUM METAL—GAS REACTIONS. INTERACTION OF LITHIUM METAL WITH AIR AND ITS COMPONENT GASES. Meyer M. Markowitz and Daniel A. Boryta (Foote Mineral Co., Exton, Penna.). J. Chem. Eng. Data, 7: 586-91(Oct. 1962).

Studies were carried out to resolve the reactions occurring when Li dispersions are exposed to air and to determine the role of water in the corrosion of Li. Exposure of Li dispersions to 50% humidity air at 27°C showed that the initial products formed were primarily LiOH and $Li_3N$ and that after ~1 hr, LiOH, $LiOH \cdot H_2O$, and $NH_3$ were formed by hydrolysis of $Li_3N$ and LiOH. Thermogravimetric (TGA) analysis experiments with dry and wet Ar, air, $N_2$, $O_2$, and $CO_2$ showed that the dry gases are inert to Li, but significant weight gains are observed with wet gases. Differential thermal analysis of the Li-$N_2$ reaction shows an exothermic reaction at ~150°C, whereas TGA indicates the onset of rapid nitridation at ~170°C. The slow reaction of Li with wet $CO_2$ is interpreted in terms of protective coatings. It is suggested that the black coating formed on Li after exposure to wet gases is really amorphous Li metal as viewed through a thin, transparent LiOH coating. (D.L.C.)

**4523** SPECIFIC HEAT OF SOME HIGH TEMPERATURE MATERIALS. B. E. Walker, Jr., C. T. Ewing, and R. R. Miller (Naval Research Lab., Washington, D. C.). J. Chem. Eng. Data, 7: 595-7(Oct. 1962).

Heat capacities were measured at 30 to 800°C for BeO; Be; BeO–Be; BeO–Be–Mo cermets; beryllides of Ta, Zr, Mo, Ti, and Nb; BeO–beryllide mixtures; SiC; SiC–graphite mixtures; BN; and BN–graphite mixtures. The results for

BeO, Be, SiC, and BN are compared to those obtained by other investigators. The additive law for specific heat is shown to be valid for the beryllide compound and cermet mixtures. (D.L.C.)

**4524** DIFFUSION OF KRYPTON-85 IN DENSE GASES. Leo Durbin and Riki Kobayashi (Rice Univ., Houston, Tex.). J. Chem. Phys., 37: 1643-54(Oct. 15, 1962).

With two high-pressure quasi-stationary diffusion cells, one depending upon ionization current measurement and the other scintillation detection of radioactive tracer activity, Fick's law diffusivities were determined for the diffusion of tracer amounts of $Kr^{85}$ in dense gases of Kr, Ar, N, He, $CO_2$, and $C_2H_4$ for isotherms about room temperature and densities to 15 mole/liter. In order to obtain absolute diffusivities, the cross-sectional area to length ratio of a primary standard porous plug consisting of a bundle of glass capillaries was precisely determined by weight-of-mercury and resistance-of-mercury calibrations. Stirring in the end chambers of the ionization cell was found to increase the determined diffusivity of $Kr^{85}$ in argon at 35°C by as much as 4.5% at a density of 12 mole/liter. The density–diffusivity product increases with density in the lower density region below about five moles per liter for all the isotherms. Extrapolations of the experimental data to low densities yield diffusivities which are in good agreement with low-pressure results by others and dilute-gas-theory predictions. Krypton self-diffusion coefficients calculated agree remarkably well with the experimental data over the density range investigated. The binary diffusivities of $Kr^{85}$ in dense base gases of argon, nitrogen, and ethylene are best predicted by the real-gas modified Enskog theory with PVT properties evaluated at a base-gas reduced temperature corresponding to the temperature of the system reduced by the mixed interaction potential temperature. In terms of precision of results and technological ease of operation the ionization cell proved to be superior to the scintillation cell. (auth)

**4525** FIELD DESORPTION OF CESIUM FROM TUNGSTEN. H. Utsugi and R. Gomer (Univ. of Chicago). J. Chem. Phys., 37: 1720-2(Oct. 15, 1962).

The field desorption of Cs from tungsten was investigated at low coverage. The results are best explained on the basis of a polar groundstate and suggest that an adiabatic transition is involved in the desorption process. On this basis the polarizability of adsorbed Cs is found to be close to that of the free atom. The results are very similar to those obtained with Ba. (auth)

**4526** POLARIZABILITY CHANGE IN LIQUIDS DUE TO MANY-BODY INTERACTIONS. Robert Yaris and Bernard Kirtman (Univ. of Washington, Seattle). J. Chem. Phys., 37: 1775-9(Oct. 15, 1962).

Approximate quantum-mechanical expressions for the change in polarizability due to many-body interactions in spherically symmetric liquids, or dense gases, were derived by a variational form of perturbation theory. The expressions are evaluated using Linder's continuum model for the liquid and Slater-type wavefunctions. It is shown that the change in polarizability is approximately $[3g\alpha^2/8(ea_0)^2]$, where $\alpha$ is the unperturbed polarizability and g is a parameter which depends on the dielectric constant and molar volume of the liquid. The predicted increase in polarizability varied from 0.042% for He to 3.54% for Xe. (auth)

**4527** HIGH-PRESSURE MASS SPECTROMETRIC STUDY OF REACTIONS OF RARE GASES WITH $N_2$ AND CO. M. S. B. Munson, F. H. Field, and J. L. Franklin (Humble Oil and Refining Co., Baytown, Tex.). J. Chem. Phys., 37: 1790-9(Oct. 15, 1962).

Studies were made in a mass spectrometer at ionization chamber pressures of about 160 μ on mixtures of rare gases, R = He, Ne, Ar, Kr, and Xe, with $N_2$ or CO. The ions $R_2^+$, $ArN_2^+$, $KrN_2^+$, $XeN_2^+$, $ArCO^+$, $XeCO^+$, $N_4^+$, and $C_2O_2^+$ were observed in the mixtures as a result of reactions of excited rare-gas atoms. The addition of Ar to $N_2$ enhanced the formation of $N_4^+$ by reactions initiated by excited states of Ar; the addition of Ar or Kr to CO promoted the formation of $C_2O_2^+$ through reactions initiated by excited states of Ar and Kr. Rate constants determined for the reactions $ArN_2^+ + N_2 = N_4^+ + Ar$ and $KrCO^+ + CO = C_2O_2^+ + Kr$ at a repeller field strength of 50 V/cm were $k = 1 \times ^{-10}$ cc/molecule-sec and $k = 3 \times 10^{-10}$ cc/molecule-sec, respectively. Other combinations of rare gases with $N_2$ or CO showed no such promotional effect on the formation of $N_4^+$ or $C_2O_2^+$. Ratios of the rate constants for the formation of $RN_2^+$ and $R_2^+$ in rare-gas-nitrogen mixtures and for the formation of $RCO^+$ and $R_2^+$ in rare-gas-carbon monoxide systems were also determined. At high pressures of $N_2$ or CO alone the formation of $N_4^+$ or $C_2O_2^+$ was observed, and the reaction was a bimolecular chemi-ionization involving highly excited $N_2$ or CO. At still higher pressures the ions were formed by termolecular ion-molecule processes. At sufficiently high electron energies in binary mixtures of $N_2$ or CO with different rare gases, $RC^+$, $RN^+$, $C_2O^+$, $CO_2^+$, and $N_3^+$ were formed. The $N_3^+$ and $RN^+$ ions were formed by the reaction of excited nitrogen molecule ions with R and/or $N_2$, and the relative rates of these reactions were determined. No compound ions between He or Ne and $N_2$ or CO were observed under any of the conditions of the experiments. (auth)

**4528** NUCLEAR MOMENTS AND INTERMEDIATE COUPLING. B. G. Wybourne (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 37: 1807-11(Oct. 15, 1962).

The effect of intermediate coupling on the calculation of the nuclear moments of the rare earths from analyses of hyperfine structure was examined. It is shown that the observed hyperfine splittings may be satisfactorily interpreted as due to the interaction of the spin and orbital moments of 4f electrons with the nuclear magnetic and electric quadrupole moments. The interaction of the electron-spin moments with the nuclear magnetic moment is shown to be very sensitive to the form of the coupling. The consistency of the measurements of nuclear moments by atomic-beam and paramagnetic resonances is discussed. Instead of the more usual spin-Hamiltonian formalism, the matrix elements of the interactions were calculated explicitly in terms of the actual quantum numbers of the states involved. Calculations are presented for $Pr^{141}$ and $Ho^{165}$. (auth)

**4529** ELECTRON SPIN RESONANCE IN POLYCRYSTALLINE GRAPHITE. L. S. Singer and G. Wagoner (Union Carbide Corp., Parma, Ohio). J. Chem. Phys., 37: 1812-17(Oct. 15, 1962).

The electron spin resonance of polycrystalline graphite is shown to be due to charge carriers, as for single crystals. For lampblack-base graphite, the variation in g value with temperature agreed approximately with that for single crystal graphite if it was assumed that the spins effectively average out the anisotropic interactions by rapid intercrystallite diffusion. The magnitude and temperature dependence of the spin susceptibility were found to be in excellent agreement with theoretical predictions for the charge carriers in perfect graphite. Complications of measuring the materials are discussed, including effects of skin depth and microwave heating and the dependence upon crystallite size and sample purity. It was found that two types of impurities can affect the resonance; those which become ionized and shift the Fermi level, and large un-ionized atoms which do not shift the Fermi level but act as efficient scattering centers for shortening the spin-lattice relaxation time. (auth)

**4530** MASS -SPECTROMETRIC STUDY OF THE MAGNESIUM HALIDES. J. Berkowitz (Argonne National Lab., Ill.) and J. R. Marquart. J. Chem. Phys., 37: 1853-65(Oct. 15, 1962). (TID-16025)

The vapor composition of four magnesium halides was studied by mass analyzing the vapor effusing from a Knudsen cell. In each instance, ~1% dimer and 0.01% trimer were observed. Heats of sublimation were measured by second- and third-law methods. The discrepancy between the two methods varied from 2 kcal/mole for $MgI_2$ to 5 kcal/mole for $MgF_2$, with the third-law method giving consistently lower values. The experimental heats of ionization of the monomers were in fair agreement with calculations based on an ionic model. The fragmentation pattern of the fluoride was anomalous as it was with the alkali-halide systems. The measured relative ionization cross sections were in surprisingly good agreement with the relative electric polarizabilities of the anions. (auth)

**4531** INTERRUPTION OF NUCLEAR SPIN DIFFUSION. D. A. Jennings and W. H. Tanttilla (Univ. of Colorado, Boulder). J. Chem. Phys., 37: 1874-6(Oct. 15, 1962).

Experimental results are shown in which the nuclear spin diffusion responsible for nuclear relaxation at low temperature, under certain circumstances, can be interrupted by introducing strains into crystals either by the paramagnetic impurity introduced into the crystal or by surface strains made to be significant by grinding the sample to a powder. Nuclei with large quadrupole moments, such as iodine, have their spin diffusion strongly interrupted whereas nuclei with no quadrupole moment, such as fluorine, show no effect of strains on the spin diffusion. The interpretations are made from measured values of the spin-lattice relaxation time at liquid-helium temperature. (auth)

**4532** PARAMAGNETIC RESONANCE IN ORIENTED GROUND-STATE TRIPLET MOLECULES. Roy W. Brandon, Gerhard L. Closs, and Clyde A. Hutchison, Jr. (Univ. of Chicago). J. Chem. Phys., 37: 1878-9(Oct. 15, 1962).

A triplet-state paramagnetic resonance spectrum was observed in single crystals of dilute solid solutions of diphenyldiazomethane in benzophenone irradiated with visible light at the boiling temperature of $N_2$. It is believed that the resonance arises from the loss of $N_2$ from the diazo compound forming diphenylmethylene. The spectrum consisted of sharp lines with approximately 10-G width between maximum slope points. The long persistence of the spectrum in the absence of light indicates that it arises from a ground-state triplet. (P.C.H.)

**4533** OXYGEN-17 HYPERFINE STRUCTURE IN ELECTRON PARAMAGNETIC RESONANCE. James C. Baird (California Research Corp., Richmond). J. Chem. Phys., 37: 1879-80(Oct. 15, 1962).

The hyperfine structure for $O^{17}$ and $N^{14}$ splittings in an organic radical, which is a model for nitric oxide, were compared. The relatively stable and simple organic free radical di-sec-butyl nitric oxide was enriched to 3.94% $O^{17}$, and the $O^{17}$ hyperfine structure observed in solution electron paramagnetic resonance. The $O^{17}$ isotropic hfs in nitric oxide was calculated. It is given by the same mechanism involved in the nitrogen hfs; predominantly from cross terms, in the configuration interaction wave function, between the ground state ($2\pi$) and various excited states having one ($2\pi$) and two ($\delta$) unpaired electrons. Agreement between the calculated splitting for $O^{17}$ and that observed in the model compound was quite good. (P.C.H.)

**4534** THIRD-ORDER INTERACTION OF XENON WITH GRAPHITIC CARBON. John R. Sams, Jr. (Univ. of Washington, Seattle). J. Chem. Phys., 37: 1883-4(Oct. 15, 1962).

Third-order gas-surface virial coefficients were obtained for the interaction of Xe with highly graphitized carbon black P33 (2700°C) at the surface. It was found that the coincidence between n-dimensional critical temperatures and (n − 1)-dimensional Boyle temperatures hold for krypton as well as for argon. Also, approximate two-dimensional Boyle temperatures of 45 and 213°K were predicted for neon and krypton, respectively, when interacting with graphitized carbon black surfaces. (P.C.H.)

**4535** SPIN DISTRIBUTION IN KETYL RADICALS. Noboru Hirota (Washington Univ., St. Louis). J. Chem. Phys., 37: 1884-5(Oct. 15, 1962).

Various types of benzophenone ketyls were prepared by the reaction with alkali, alkaline earth, and rare earth metals and their ESR spectra were studied. In the aliphatic ether solvents DME, THF, and Me-THF, it was found that the monomer ketyl radicals are ion paired and that the spectra show lines due to splittings by protons and metal. Assignments of coupling constants for various benzophenone ketyls gave complete agreement between experimental spectra and predicted ones in intensity ratio. Discussion is also given on splitting mechanism for $C^{13}$. (P.C.H.)

**4536** HIGH-PRESSURE TRANSITION IN RbF. G. J. Piermarini and C. E. Weir (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 37: 1887-8(Oct. 15, 1962).

X-ray-diffraction studies were completed on anhydrous RbF and it was found that the normal fcc structure is converted to the sc structure at elevated pressures. The unit cube edge ($a_0$) changed from 5.64 Å in the fcc structure to 3.27 Å in the sc form, resulting in a molar volume decrease of approximately 20%. The pressure at which the transition occurred could not be obtained with precision and was calculated. At 9 kbar only fcc material was present, while at 12 kbar the sc form was found. (P.C.H.)

**4537** NUCLEAR MAGNETIC RESONANCE OF $Cl^{35}$ IN PARAMAGNETIC $FeCl_2$. R. G. Barnes and S. L. Segel (Ames Lab., Ames, Iowa). J. Chem. Phys., 37: 1895-6 (Oct. 15, 1962). (IS-465)

The nuclear magnetic resonance spectrum of $Cl^{35}$ was investigated at room temperature in single and polycrystal ferrous chloride, $FeCl_2$. The dependence of the spectrum on magnetic field strength was interpreted in terms of the combined effects of isotropic and anisotropic paramagnetic shifts and a nuclear quadrupole interaction. The resonance results confirmed that the magnetic susceptibility of $FeCl_2$ is essentially isotropic at room temperature. Isotropic and anisotropic shift parameters and quadrupole coupling constant are tabulated. (P.C.H.)

**4538** CATHODIC ACTION OF THE URANIUM CHELATE COMPOUNDS AT THE DROPPING MERCURY ELECTRODE. II. URANYL-GLUTAMATE COMPLEX. Tsai-Teh Lai, Teh-Liang Chang, and Hua Chang (Cheng Kung Univ., China). J. Chinese Chem. Soc. (Taiwan), 8: 23-32(Mar. 1, 1961). (In English)

The polarographic behavior of a tridentate chelate compound of uranyl-glutamate was investigated over the pH range of 1.5 to 5.5. The first wave of one-electron reduction and diffusion-controlled reversible wave was applied through this pH range. Below pH 1.9 there was no chelation, and above pH 5.5 turbidity ensued. At pH 3.0 to 3.9 the diffusion current was independent of pH value and the diffusion current constant was calculated to be 2.08. The proportionality between uranyl ion concentration and diffusion current held within the narrow range of $2.2 \times 10^{-4}$ to $3.3 \times 10^{-3}$ M with 1.3% average deviation of the mean. The chelate forms and electrode reactions identified from the half-wave potential and diffusion current data were: pH 4.4–5.5, $UO_2(G)_2^{2-} + e = UO_2^{+} + 2G^{2-}$, pH 3.0–4.4, $UO_2(HG)_2 + H^+ + e = UO_2(HG) + H_2G$, and pH <1.9, $UO_2^{2+} + e = UO_2^{+}$. (auth)

**4539** OXIDATION POTENTIAL OF THE CEROUS-CERIC ELECTRODE IN DILUTE SULFURIC ACID SOLUTIONS. Kuan Pan, Kai-tee Hsieh, and Chen-hanson Ting (National Taiwan Univ., China). J. Chinese Chem. Soc. (Taiwan), 8: 147-55(Sept. 1961). (In English)

The oxidation potential of the Ce(III)–Ce(IV) couple in sulfuric acid over the concentration range of 0.05 to 0.5F was observed at 25°C by using the $Pt-PbO_2/PbSO_4, SO_4^{2-}$ electrode as the reference electrode. The free energy change for the reaction $2Ce^{3+} + PbO_2 + 4H^+ + SO_4^{2-} = 2Ce^{4+} + PbSO_4 + 2H_2O$ was estimated. (auth)

**4540** PURE ARAGONITE SYNTHESIS. Yasushi Kitano (Nagoya Univ., Japan), Kilho Park, and Donald W. Hood. J. Geophys. Res., 67: 4873-4(Nov. 1962).

By slow removal of $CO_2$ from $Ca(HCO_3)_2$ solution containing $MgCl_2$ at room temperature, pure and homogeneous aragonite crystals were obtained. During the crystal syntheses, labeling with either or both $C^{14}$ and $Ca^{45}$ was feasible. (auth)

**4541** A MODEL FOR THE RATIONALIZATION OF SALINE AND METALLIC HYDRIDE FORMATION. T. R. P. Gibb, Jr. (Tufts Univ., Medford, Mass.). J. Inorg. & Nucl. Chem., 24: 349-56(Apr. 1962). (In English)

The exothermic, reversible formation of solid hydrides from the elements is rationalized on the basis of a model in which the hydride consists of hydrogen anions and metal cations, the latter likewise engaging in metal–metal bonding in the metallic hydrides. The lattice energy is evaluated as the sum of the Madelung energy and this metal–metal interaction energy. Two empirical methods of estimating the latter are suggested, one involving crystal field stabilization. The total lattice energy so calculated is compared semi-quantitatively with the sum of the endothermic factors in a Born-Haber cycle. The energy balance is favorable with few exceptions for hydrides known to form directly, and unfavorable for hydrides which evidently do not form directly from the elements. (auth)

**4542** PREPARATION OF ANHYDROUS LANTHANIDE HALIDES, ESPECIALLY IODIDES. M. D. Taylor and C. P. Carter (Howard Univ., Washington, D. C.). J. Inorg. & Nucl. Chem., 24: 387-91(Apr. 1962). (In English)

A general method is described which can be used to synthesize nearly all the lanthanide halides in high purity and good yield. It involves heating in vacuo, a molecularly dispersed mixture of hydrated lanthanide halide with the proper ammonium halide until the water and ammonium halide are expelled to leave pure, anhydrous lanthanide halide. All tri-halides except the iodides of samarium and europium are obtained. These are obtained as di-halides. Optimum conditions for synthesis are discussed. The procedure is the only one which has been reported for preparing pure anhydrous iodides with relatively simple apparatus and technique. (auth)

**4543** DIFFERENTIAL THERMAL ANALYSIS OF THE OXALATES OF LANTHANUM, CERIUM AND THORIUM. O. K. Srivastava and A. R. Vasudeva Murthy (Department of Inorganic and Physical Chemistry, Indian Inst. of Science, Bangalore). J. Sci. Ind. Res. (India), 21B: 525-7(1962).

Decomposition of hydrates of lanthanum, cerium, and thorium oxalates was studied by differential thermal analysis (D.T.A.) using a rate of heating of 23–25°C/min. The endothermic peaks observed in the D.T.A. curves indicate the different stages in the hydration and decomposition of the oxalates. Phase changes in the oxide could not be detected as the oxidation of carbon is pronounced after 600°C. In the case of thorium oxalate, the oxidation of carbon starts at as low a temperature as 480°C, probably due to catalytic oxidation. Activation energies calculated for each of the different reactions show that they are smaller for dehydration reactions as compared to decomposition reactions. (auth)

**4544** COMPLEX FORMATION BETWEEN CERIUM(III) AND SEMICARBAZIDE HYDROCHLORIDE, UREA AND THIOUREA. M. C. Saxena (Univ. of Saugar, Saugor, India). J. Sci. Ind. Res. (India), 21B: 558-9(1962).

Conductometric and pH measurements show that Ce(III) ions form a single complex with semicarbazide hydrochloride and thiourea in the ratio 1 : 1, and five complexes with urea in the ratio of 2 : 1, 1 : 1, 1 : 2, 1 : 3, and 1 : 4. (auth)

**4545** ADSORPTION OF WATER VAPOUR ON A CLEAVAGE SURFACE OF LITHIUM FLUORIDE. Koreo Kinosita, Hiroomi Kojima, and Hideshi Yokota (Gakushuin Univ., Tokyo). Japan. J. Appl. Phys., 1: 234(Oct. 1962). (In English)

The refractive index as well as the thickness of the adsorbed water vapor film were evaluated by a method of polarimetric analysis. A freshly cleaved surface of LiF was placed in an airtight chamber mounted on a polarization spectrometer. The relative water vapor pressure in the chamber was varied, and changes due to adsorption in the principal angle of incidence and in the amplitude reflectivity ratio for this angle of incidence were observed. (W.D.M.)

**4546** A RELATION AMONG THE ANHARMONICITY CONSTANTS OF A SET OF ISOTOPIC POLYATOMIC MOLECULES. L. M. Sverdlov. Opt. Spectry. (USSR) (English Transl.), 13: 29-30(July 1962).

A relation among the anharmonicity constants of a set of isotopic polyatomic molecules has been formulated; its validity is corroborated by the existing data on the anharmonicity constants of isotopically substituted water, acetylene, and methane. (auth)

**4547** THE SPECTRA OF DIVALENT RARE EARTH IONS IN CRYSTALS OF ALKALINE EARTH FLUORIDES. II. EUROPIUM AND YTTRIUM. A. A. Kaplyanskii and P. P. Feofilov. Opt. Spectry. (USSR) (English Transl.), 13: 129-32(Aug. 1962).

The absorption and luminescence spectra of divalent ions of europium and ytterbium introduced into monocrystals of the fluorides of Ca, Sr, and Ba were investigated at 293, 77, and 4.2°K. It was established that there is a regular shift of the absorption spectra with change in host cation. The spectra were considered to be manifestations of electron transitions between terms of the $4f^k$ configuration and terms of mixed configurations, particularly $4f^{k-1}5d$ and $4f^{k-1}6s$. (auth)

**4548** STABILIZATION OF HIGH-TEMPERATURE FORMS OF DICALCIUM SILICATES BY LANTHANOID ORTHOSILICATES. N. A. Toropov and N. F. Fedorov. Zh. Prikl. Khim., 35: 2156-61(Oct. 1962). (In Russian)

Petrographic and x-ray analysis of yttrium orthosilicate–calcium orthosilicate systems indicate a limited system based on calcium orthosilicate solid solution series. The maximum solid solution concentration is 42.5 ± 2.5 wt % of yttrium orthosilicate. Binary calcium silicate modifications $\alpha$, $\alpha'$, and $\beta$ are formed at high temperatures, and at still higher temperatures the formations demand a larger amount of stabilizing admixtures (La, Nd, and Y orthosilicate). (R.V.J.)

**4549** THE MEASURING OF DIFFUSION COEFFICIENTS IN $SrCl_2$ SOLUTIONS BY RADIOACTIVE TRACERS. M. S. Zakharievskii and Sun-gi Li. Vestnik Leningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 131-4(1962). (In Russian)

A method for measuring diffusion coefficients by means of $\beta$-radioactive tracers is given. The diffusion coefficients of $SrCl_2$ solutions were measured by the method proposed. (auth)

**4550** THE ENTHALPY OF THE FORMATION OF DOUBLE COMPOUNDS OF NIOBIUM OXYTRICHLORIDE WITH NaCl AND KCl. T. S. Shemyakina, E. K. Smirnova, and S. A. Shchukarev. Vestnik Leningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 155-7(1962). (In Russian)

$NbOCl_3 \cdot NaCl$, $NbOCl_3 \cdot KCl$, and $NbOCl_3 \cdot 2KCl$ were synthesized. The enthalpies of hydrolysis of the compounds and their mixtures ($NbOCl_3 + NaCl$), ($NbOCl_3 + KCl$), and ($NbOCl_3 + 2KCl$) were determined by means of the calorimetric method. On the basis of the data, the enthalpies of the formation of double compounds of niobium oxytrichloride with sodium and potassium chlorides from $NbOCl_3$ and MCl were calculated as follows: $H_{form} \cdot NbOCl \cdot NaCl = 1.1 \pm 0.6$ kcal/mol, $H_{form} \cdot NbOCl_3 \cdot KCl = -7.2 \pm 0.6$ kcal/mol, and $H_{form} \cdot NbOCl_3 \cdot 2KCl = -4.5 \pm 0.4$ kcal/mol. (auth)

**4551** PRIMARY SOLID HYDRIDES. Thomas R. P. Gibb, Jr. (Tufts Univ., Medford, Mass.). p.315-522 of "Progress in Inorganic Chemistry." F. Albert Cotton, ed. New York-London, Interscience Publishers, 1962.

A review of metallic hydrides is presented from a theoretical-chemical point of view. The bonding character of hydrides is discussed at length, and the structure (internuclear distances, molar volume, etc.) is considered. The magnetic and electric properties of hydrides are described. The thermodynamics of dissociation and the phase relations of hydrides are discussed. Finally, the preparation of hydrides and the nature of ternary hydrides are considered. (D.L.C.)

**4552** INTERCALATION OF COBALT(II) CHLORIDE IN GRAPHITE. J. J. Pitts (Olin-Mathieson Corp., New Haven, Conn.) and L. L. Lyon. p.132-8 of "Proceedings of the Fifth Conference on Carbon." [New York], Pergamon Press, 1962. (LADC-4753)

The optimum conditions for the preparation of a cobalt (II) chloride compound with graphite are: intimate mixture of anhydrous $CoCl_2$ and graphite powder in a flowing stream of chlorine heated at 350°C for 15 hours. Two different graphites intercalated similar amounts of $CoCl_2$. Graphitized carbon black did not undergo reaction under similar conditions. The analytical results indicated that the atomic ratio of cobalt to chlorine is 1 to 2 in the intercalated compounds regardless of the amount of reaction that has taken place, $CoCl_{1.97}C_{286}$ to $CoCl_{2.01}C_{21}$. A minimum of 0.5 atom of oxygen per cobalt atom was present in the water washed compound. The oxygen may be present in the form of water. No evidence was found that a volatile compound of cobalt was present in the reaction mixture. Magnetic susceptibility measurements could not detect the presence of Co(III) oxidation state. X-ray diffraction indicated that some separation of the graphite layers had occurred. Water cannot dissolve out the cobalt chloride because compounds retained as much as 34% $CoCl_2$ after being repeatedly washed with water until a negative chloride test was obtained. Attempts to form amminates were unsuccessful. Adsorption experiments indicated that nitrogen could not penetrate the layers in the intercalation compound. (auth)

**4553** THERMAL DECOMPOSITION OF YTTRIUM, SCANDIUM AND HEAVY LANTHANON OXALATES AND CARBONATES. M. Clarus Strouth. Thesis, East Lansing, Mich., Michigan State Univ., 1962. 155p.

The decomposition scheme followed by yttrium, scandium, and the heavy lanthanon oxalates and carbonates was studied by differential thermal analysis. The compounds were prepared from their respective oxides. The carbonates of yttrium and the lanthanons were precipitated in a homogeneous reaction involving the hydrolysis of the trichloroacetates. Scandium oxycarbonate resulted from repeated washings of freshly precipitated scandium ammonium carbonate, which formed on addition of a 1 M solution of ammonium carbonate to a scandium nitrate solution. All the oxalates were precipitated from rare earth nitrate solutions using a saturated oxalic acid solution as the precipitating agent. Decomposition of the carbonates resulted in a step-wise loss of carbon dioxide as indicated by the equation: $Ln_2(CO_3)_3 \rightarrow Ln_2O(CO_3)_2 \rightarrow Ln_2O_2CO_3 \rightarrow Ln_2O_3$. In the case of the oxycarbonates the first reaction was not observed. The final product in the decomposition of terbium carbonate and oxalate was $Tb_4O_7$ instead of the sesquioxide. The oxalates yielded the intermediate products as formulated in the following reaction mechanism: $Ln_2(C_2O_4)_3 \cdot \underline{x}H_2O \rightarrow Ln_2(C_2O_4)_3 \cdot 1\text{-}2H_2O \rightarrow Ln_2(C_2O_4)_2CO_3$ and $Ln_2(C_2O_4)(CO_3)_2 \rightarrow Ln_2O(CO_3)_2 \rightarrow Ln_2O_2CO_3 \rightarrow Ln_2O_3$. The presence of the various products was verified by x-ray and infrared analyses as well as by quantitative chemical measurements. A diffraction pattern was obtained for one of the oxycarbonates after an extended tempering period, and assignment of (hkl) values was made in the case of the three normal carbonates. A carbon dioxide atmosphere was introduced into the thermal analysis furnace to note the general effect on the decomposition curves of the carbonates and oxalates, and aid in separating some of the intermediate products for analysis. (Dissertation Abstr., 23: No. 4, 1962)

**4554** THE MOLECULAR BEAM ELECTRIC RESONANCE SPECTRA OF SOME ALKALI HALIDES. Lewis Peter Gold. Thesis, Boston, Harvard Univ., 1962. 93p.

Molecular beam electric resonance spectra were obtained and analyzed for the two lowest vibrational states of $Li^7F$, the three lowest vibrational states of $Li^6F$ and $NaCl^{35}$, and the ground vibrational state of $Li^7Cl^{35}$. The transition observed in each case was the rotational angular momentum reorientation $J = 1$, $M_J = 0 \rightarrow \pm 1$. For lithium fluoride, the following constants were determined for each state: lithium quadrupole coupling constants, spin-rotation constants, and Stark effect constants $\mu^2 A_v$ where $\mu_v$ and $A_v$ are the dipole moment and moment of inertia, respectively, of the $v^{th}$ vibrational state of the molecule. The variation of the constants with vibrational state is discussed. The ratio of the quadrupole coupling constants at the lithium nuclei in $Li^6F$ and $Li^7F$ was found to be in agreement with earlier determinations; knowledge of the ratio permitted a calculation of the quadrupole moment of the $Li^6$ nucleus. The dipole moment of sodium chloride was determined for each of the three vibrational states observed. Measurements of the quadrupole coupling constants at each nucleus for the ground vibrational state are described for both $NaCl^{35}$ and $Li^7Cl^{35}$. A description is given of the methods by which the molecular beam spectra were analyzed with the aid of a high-speed digital computer. Plans and operating instructions are given for the mass spectrometer electromagnet used on the molecular beam spectrometer. (Dissertation Abstr., 23: No. 4, 1962)

**4555** COMPOUNDS OF ZIRCONIUM AND METHODS OF PREPARING SAME. Reginald S. Dean (to International Metallurgical Corp.). British Patent 909,755. Nov. 7, 1962.

A manufacturing process is described for producing and compacting large chemically homogeneous flakes of graphite texture having the chemical formula ZrCl. The process involves the electrolysis of a melt of 65% $SrCl_2$ and 35% NaCl containing about 3% zirconium as a salt soluble in dilute HCl. (R.J.S.)

**4556** URANIUM OXIDE SOLS. (to W. R. Grace and Co.). British Patent 910,212. Nov. 14, 1962.

A method is described for preparing a hydrothermally stable urania sol in which the uranium is in the +4 oxidation state. The process involves removal of anions from a solution of uranium tetrachloride in water and/or heavy water by hydrolysis until the solution is substantially free from electrolytes. (R.J.S.)

**4557** PROCESS FOR THE PRODUCTION OF PURE ZIRCONIUM TETRACHLORIDE AND HAFNIUM/ZIRCONIUM TETRACHLORIDE BY SUBLIMATION. (to Deutsche Gold und Silber Scheideanstalt Vormals Roessler). British Patent 910,289. Nov. 14, 1962.

A process is described for the production of pure zirconium tetrachloride or pure hafnium/zirconium tetrachloride from crude tetrachlorides of these metals by sublimation carried out in an atmosphere containing hydrocarbons with a boiling point preferably below 100°C. (R.J.S.)

**4558** PURIFICATION OF STRONTIUM NITRATE. Willard S. Bundy and Albert Pavlik, Jr. (to Barium and Chemicals, Inc.). U. S. Patent 3,065,052. Nov. 20, 1962.

A process is described for the substantially complete removal of impurities from commercial strontium nitrate. The chemistry of the process is explained in detail. (R.J.S.)

## Organic Chemistry

**4559** (HW-SA-2796) THE NEUTRAL ORGANOPHOSPHORUS COMPOUNDS AS EXTRACTANTS. L. L. Burger (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Oct. 15, 1962]. Contract AT(45-1)-1350. 29p.

The properties of neutral organophosphorus compounds as solvents, in particular, solvents which form solvation complexes with inorganic molecules, were considered. Physical properties of the compounds are described. Phosphines, phosphine oxides, phosphinates, phosphonates, and phosphates were studied with respect to complex formation with inorganic compounds. The extraction of mineral acids by these compounds is discussed. (M.C.G.)

**4560** (TID-17369) THE KINETICS OF ACID-CATALYZED AROMATIC HYDROGEN EXCHANGE IN METHOXYBENZENES. A. J. Kresge and Y. Sato (Illinois Inst. of Tech., Chicago). [1961]. Contract [AT(11-1)-1025]. 14p.

Evidence is presented which indicates that the mechanism $H'Ar + HA \rightleftharpoons H'ArH^+ + A^- \rightleftharpoons HAr + H'A$ is operative for aromatic hydrogen exchange in 1,3-dimethoxybenzene (DMB). Exchange reactions were followed by measuring the rate of loss of tritium from labeled aromatics to acid. (M.C.G.)

**4561** (UCRL-10350) BIO-ORGANIC CHEMISTRY QUARTERLY REPORT, MARCH THROUGH MAY 1962. (California. Univ., Berkeley. Lawrence Radiation Lab.). July 5, 1962. Contract W-7405-eng-48. 92p.

Results of experiments designed to identify the electron donor in the interaction between Mn(IV) hematoporphyrin (IX) and water and to clarify the character of its resultant oxidized form are presented. The interaction was shown to result in the destruction of porphyrin, the formation of an organic peroxide, and/or the liberation of oxygen. In other work, the vapor-phase chromatographic behavior of the tetra-o-acetyl pentopyranoses were examined. It was found that increases in intra-molecular steric repulsions apparently result in increases in retention times. Results of investigations are also included on the mobilities of the gluco- and talo- isomers of hexano-γ-lactones, and those obtained in an examination of the structure and chromatographic properties of trimethylsilyl ethers of carbohydrates. Spectral data from experiments concerning the action of trimethylsilyl ethers on pyridine solutions prepared from crystalline aldoses and from dried syrupy mutarotated mixtures of isomers are given. Progress is also reported in experiments on light-dark transient changes in concentration of sugar phosphates other than ribulose diphosphate in Chlorella, technique development for preparation of a pigment-protein complex from spinach and barley chloroplasts, examination of the chemical composition and substructure of lamellae isolated from spinacea oleracea chloroplasts, experiments concerning the occurrence and isolation of a fat-soluble fragrant compound in Magnolia foliage, investigations concerning the effects of environmental conditions on weight, specific cholinesterase activity, specific hexokinase activity, and protein content in rat brains, and studies of G values for the radiation decomposition of nucleic acid constituents. Data and information are also included on the recovery of $C^{14}$ from the ion-acceleration isotope separator. (J.R.D.)

**4562** REACTION OF METHYL-$d_3$ RADICALS WITH ISOBUTANE, ISOBUTANE-2-d, AND PROPANE. W. M. Jackson, J. R. McNesby, and B. deB. Darwent (Catholic Univ. of America, Washington, D. C.). J. Chem. Phys., 37: 1610-15(Oct. 15, 1962).

The relative rates of abstraction by $CD_3$ radicals of primary, secondary, and tertiary H atoms were measured. Using a standard rate constant for abstraction of D from acetone-$d_6$, the following rate constants were obtained: k(mole$^{-1}$ cc sec$^{-1}$); $CD_3 + CD_3COCD_3 \rightarrow CD_4 + CD_2COCD_3 = 3.5 \times 10^{10}T^{½} \exp(-11\,100/RT)$, $CD_3 + (CH_3)_3CD \rightarrow CD_4 + (CH_3)_3C = 0.88 \times 10^{10}T^{½} \exp(-9200/RT)$, $CD_3 + (CH_3)_3CD \rightarrow CD_3H + CH_2 - CD(CH_3)_2 = 4.38 \times 10^{10}T^{½} \exp(-11\,100/RT)$, $CD_3 + (CH_3)_3CH \rightarrow CD_3H + (CH_3)_3C = 0.70 \times 10^{10}T^{½} \exp(-7600/RT)$. Isotope effects obtained were, for secondary H and D in propane $k_H/k_D = 1.04 \exp(1400/RT)$, and for tertiary H and D in isobutane $k_H/k_D = 0.80 \exp(1600/RT)$. The isotope effects are within experimental error of that given by the general expression for the deuterium isotope effect previously proposed $k_H/k_D = \exp(1500/RT)$, and are in excellent correspondence with previous theoretical treatment. (auth)

**4563** EFFECT OF ADDED QUENCHERS IN ORGANIC SCINTILLATOR SOLUTIONS: AROMATIC HALIDES. John L. Kropp and Milton Burton (Univ. of Notre Dame, Ind.). J. Chem. Phys., 37: 1742-51(Oct. 15, 1962).

Luminescence-intensity measurements, as affected by quencher concentration, solvent and scintillator, yield information on quenching constants, on specific rates of quenching, on mechanism of quenching, on contrast between quenching of solvent and quenching of scintillator, and on contrast between quenching in benzene as solvent and quenching in cyclohexane as solvent. For a number of aromatic bromides (and for iodobenzene), excitation transfer appears to be involved in the quenching process; in those cases the specific rates are higher than may be expected for simple diffusion-controlled reactions. Typical specific rates ($k_q$) are $\approx$ or $>2.5 \times 10^{10}$ M$^{-1}$ sec$^{-1}$ in benzene. The donor states from which excitation is transferred are not identified. In cyclohexane, calculated $k_q$ values are very much higher with an implication that the mechanism of the quenching process is quite different in such cases. Some of the results can be explained in terms of the theory of solvent domains; the data for cyclohexane suggest that the mechanism of deposition and localization of energy must also be carefully considered. (auth)

**4564** EFFECT OF ADDED QUENCHERS IN ORGANIC SCINTILLATOR SOLUTIONS: ORGANOMETALLICS. John L. Kropp and Milton Burton (Univ. of Notre Dame, Ind.). J. Chem. Phys., 37: 1752-6(Oct. 15, 1962).

Quenching constants ($\gamma_s$ and $\gamma_r$) are given for a variety of perphenyl metals (Si, Ge, Sn, Pb, Sb, and Hg) and for mercury dimethyl acting on benzene and cyclohexane solvents and p-terphenyl and DPA scintillators. Specific rates were calculated for the quenching processes and were found to break into the following classes: $<7 \times 10^9$ $M^{-1}$ $sec^{-1}$ corresponding to spin-perturbation-induced quenching (with a probability factor less than unity), and $\geqq 3 \times 10^{10}$ $M^{-1}$ $sec^{-1}$ (exceeding such calculated values), corresponding to highly favored excitation-transfer processes. The latter high values can be explained in terms of the domain theory of liquid scintillator solutions. Specific rates in the intermediate range for $GePh_4$, and perhaps for $SiPh_4$, acting on solvents were consistent with resistance to high-energy irradiation and with the attendant probability that long-lived excited states of such quenchers actually transfer excitation to the scintillator. Anomalously high quenching constants and specific rates for quenching (as well as an anomalous relationship between quenching constants for aerated and deaerated solutions) in the case of cyclohexane suggest that a proper view of energy deposition should be an initial nonlocalized excitation of the system, followed by competitive localization of excitation in one of several particular species: cyclohexane (which may immediately decompose if an excited state is directly produced), quencher, or scintillator. (auth)

**4565** LUMINESCENCE DECAY TIMES: CONCENTRATION EFFECTS. Juan Yguerabide and Milton Burton (Univ. of Notre Dame, Ind.). J. Chem. Phys., 37: 1757-74 (Oct. 15, 1962).

The optical properties (absorption spectrum, fluorescence spectrum, and luminescence decay) of solutions of 2,5-diphenyloxazole (PPO) and p-terphenyl in benzene and cyclohexane are reported as functions of solute concentration. The absorption spectra of the solutions, when plotted as extinction coefficient vs wavelength, were unaffected by scintillator concentration, but the fluorescence spectrum of PPO solutions was affected in both intensity and shape. The luminescence decay of all solutions studied was nonexponential and could be resolved into the sum of two exponential decays. The fluorescence spectra and decay curves were affected by oxygen. The interactions between excited and unexcited molecules and between unexcited molecules themselves and the effect which these interactions have on the optical properties of luminescent solutions were examined. The experimental results can be adequately explained by a mechanism which involves formation of transient dimers by an interaction between excited and unexcited molecules in addition to excitation of solute domains of unexcited solute molecules. It is shown that cage effects by themselves cannot account for the luminescent properties of the systems studied. (auth)

**4566** FLUORESCENCE QUENCHING OF A SCINTILLATION SOLUTION BY OXYGEN. I. B. Berlman and T. A. Walter (Argonne National Lab., Ill.). J. Chem. Phys., 37: 1888-9(Oct. 15, 1962).

A new method of comparing the magnitude of quenching by oxygen of the fluorescence radiation from each of a series of solute molecules in a cyclohexane solution is presented. The novelty of the technique lies in plotting $L_0/L$ vs $\tau$, in contrast to the method of plotting $L_0/L$ vs (Q). (P.C.H.)

**4567** POSITRON ANNIHILATION IN SOLID CYCLOHEXANE AS A FUNCTION OF TEMPERATURE. H. C. Clarke and B. G. Hogg (Univ. of Manitoba, Can.). J. Chem. Phys., 37: 1898-9(Oct. 15, 1962).

Positron decay in solid cyclohexane was studied from 0 to −196°C. A change in slope of the $\tau_2$ versus temperature curve at ~ −110°C was interpreted as being due to the solid-solid transition from cubic to monoclinic cyclohexane. (P.C.H.)

**4568** THE SECONDARY α-DEUTERIUM ISOTOPE EFFECT AND THE MECHANISM OF THE DIELS-ALDER REACTION. Stanley Seltzer (Brookhaven National Lab., Upton, N. Y.). Tetrahedron Letters, No. 11, 457-60(1962). (BNL-6071)

The effects of deuterium labeling on the formation of the Diels-Alder adduct from maleic anhydride and 2-methylfuran were studied. Labeled adducts II and III were prepared using maleic anhydride-$d_2$ and 2-methylfuran-5-d, respectively. The rates of decomposition of II, III, and unlabeled adduct (I) were measured at 50°C in isooctane solution. The data were used to derive first-order rate constants for the formation of the adducts; the isotope effects were found to be $k_I/k_{II} = 1.15 \pm 0.01$ and $k_I/k_{III} = 1.07 \pm 0.01$, indicating that the rate-determining reaction involves only one step. (D.L.C.)

## Radiation Chemistry and Radiochemistry

**4569** (NP-12250) RADIATION EFFECTS ON p- AND n-TYPE CATALYSTS USED IN THE THERMAL DISSOCIATION OF ETHYL ALCOHOL. Matteo Donato (Canada. Dept. of Mines and Technical Surveys. Mines Branch). Aug. 1962. 28p.

Available as Can. Dep. Mines Tech. Surv., Mines Branch Res. Rept. R 105. $0.50.

The dissociation of anhydrous ethyl alcohol was studied over the temperature range 330 to 430°C with the employment of catalysts that were previously exposed to a range of estimated "integrated" neutron doses of up to $96.6 \times 10^{18}$ $n/cm^2$. The catalysts were ZnO, an n-type semiconductor, prepared by decomposition of the carbonate, and $Cr_2O_3$, a p-type semiconductor, prepared by dehydration of the hydroxide. Measurable changes in yield and decomposition mechanism were observed as compared with the unirradiated catalysts. The variation in the behavior of the catalysts was related to the various neutron doses received, and the results are discussed in the framework of the electronic theory of catalysis on semiconductors. (auth)

**4570** (TID-7643) PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON RADIATION-INDUCED POLYMERIZATION AND GRAFT COPOLYMERIZATION, NOVEMBER 29-30, 1962. (Battelle Memorial Inst., Columbus, Ohio). Nov. 1962. 413p.

Twenty-two papers and three abstracts of papers presented at the International Symposium on Radiation-Induced Polymerization and Graft Copolymerization are given. Separate abstracts were prepared for 21 of the papers. One was previously abstracted for NSA. (M.C.G.)

**4571** (TID-7643(p.1-16)) IRRADIATION "FACTOR-DEPENDENCY" OF VINYL MONOMERS: EFFECTS OF SOME EXPERIMENTAL VARIABLES. Ed. F. Degering, S. R. Butler, G. J. Caldarella, F. E. Evans, S. D. Gabelnick, and M. Mancini (Army Natick Labs., Natick, Mass.).

Experimental results are presented from which it was concluded that atmosphere, dose rate, post-irradiation storage, temperature, and the voltage of the electron accelerator, are all significant variables for the radioinduced polymerization of vinyl monomer systems. (auth)

**4572** (TID-7643(p.28-55)) RADIATION-INDUCED POLYMERIZATION OF KETENE AND ITS DERIVATIVES. K. Hayashi, K. Fujiwara, and S. Okamura (Japanese Assn. for Radiation Research on Polymers. Osaka Labs., Osaka).

Radiation-induced polymerization and copolymerization of ketene, diketene, and dimethylketene were investigated in order to elucidate the reaction mechanisms and the structures of polymers formed. Ketene polymerized by irradiation in liquid phase with activation energy of 2.4 kcal/mole and gave a polyester type polymer, while in solid phase polymerized with activation energy of −0.13 kcal/mole and gave a mixture of polyester type and polyketone type polymers. Dimethylketene polymerized to a polyacetal type polymer both in liquid and solid phases and also copolymerized with aldehydes such as acetaldehydes, n-butyraldehyde, and benzaldehyde. Diketene polymerized only in solid phase forming a polyester type polymer, and in liquid phase, however, copolymerized with vinyl monomers such as acrylonitrile at the place of the $>C=C$ double bond. (auth)

**4573** (TID-7643(p.56-69)) RADIATION-INDUCED POLYMERIZATION OF ALPHA-OLEFINS. C. D. Wagner and D. O. Geymer (Shell Development Co., Emeryville, Calif.).

Alpha olefins in condensed phases react under ionizing radiation to form low molecular weight polymers. Chang, Yang, and Wagner examined the nature of the dimeric product from 1-hexene and found it to be inconsistent with that expected from any free radical reaction. They proposed a mechanism of polymerization involving condensation of a molecule ion and olefin. Support for an ionic mechanism was found by Collinson, Dainton, and Gillis, with radical scavengers in 1-hexadecene, and by Wagner with deuterium labeling in propylene. Further substantiation of the mechanism resulted from recent studies by Wagner of ethylene polymerization at −196°. Use of ethylene and ethylene-$d_4$ showed that a $C_2H_4$ species actually initiates the polymerization. Analysis of structure of the largely-branched monoolefinic oligomers demonstrates the uniquely random character of the propagation step. The radiation-induced ionic polymerization of alpha-olefins was compared with the radiation-induced polymerization of isobutylene. While the two processes have obvious points of difference, the same dilemma is posed in both cases in the termination step. Calculations of Samuel and Magee show that a positive ion should be neutralized by the ejected electron in about $10^{-13}$ seconds, an insufficient time for production of polymer. A way out of this difficulty is presented if olefin molecules can act as short-lived electron traps. Indeed, LeBlanc showed by conductivity experiments that even in pure n-hexane an electron spends most of its time in electron traps. An alternative solution offers itself if the positive ion and the electron can coexist in close proximity without immediate neutralization. (auth)

**4574** (TID-7643(p.70-106)) COBALT-60 GAMMA RADIATION POLYMERIZATION OF ETHYLENE. Meyer Steinberg, P. Colombo, L. Kukacka, R. N. Chapman, and George Adler (Brookhaven National Lab., Upton, N. Y.).

The yield and rate of polymerization of ethylene in a $Co^{60}$ gamma field was determined by a continuous pressure recording technique. The conditions under which the rate was measured varied in pressure from approximately 680 to less than 68 atm, in temperature from −78 to 50°C, and in intensity from 17,000 to 920,000 rad/hr. Polymerization took place in the liquid phase at −78°C at a very low rate. In the gas phase at 20 to 40°C a strong inhibition and retardation effect due to oxygen impurity was noted, and the induction period as oxygen concentration varied was determined. The experiments indicated that the effect of the presence of polymer on the polymerization rate is negligible when compared with the effect of either oxygen or ethylene pressure. The addition of argon acted as a diluent in decreasing the polymerization rate. For a series of runs using high purity gas containing $<5$ ppm $O_2$, the differential G values based on monomer alone were determined during the falling pressure period and equations were derived to express the G value and the polymerization rate as a function of ethylene pressure and radiation intensity. In the range of 150 to 600 atm pressure, 17,000 to 920,000 rad/hr intensity, and temperature in the range of 30 to 50°C the G value was proportional to the 0.82 power of the pressure, and to the −0.58 power of the intensity. At 335,000 rad/hr a maximum differential G value of 37,200 was obtained at 651 atm, while at 17,000 rad/hr a maximum value of 136,000 was reached at 555 atm. These correspond to polymer formation rates of 165 and 29 gm/liter/hr respectively. The rate expression derived from the experimental data, in terms of the formation rate Q in gm/liter/hr, pressure P in atmospheres and the radiation intensity I in rad/hr is as follows: $Q = 6.26 \times 10^{-4} P^{1.02} I^{0.42}$. In experiments performed with gas containing oxygen impurity, additions of solid substrates of alumina and molecular sieves increase the G value by a factor of 2 to 3 and the rate by a factor of 1.5 to 2 which indicates a surface effect. The polymers produced throughout these experiments consisted of fine white powder with properties dependent on pressure and irradiation conditions. Generally, the polymers showed intermediate density values of 0.93 to 0.94, possessed a high degree of crystallinity after annealing, and at lower total doses were noncrosslinked. (auth)

**4575** (TID-7643(p.109-17)) RADIATION-INDUCED IONIC POLYMERIZATION OF BUTADIENE. R. L. Webb ([American Cyanamid Co. Stamford Research Labs., Stamford, Conn.]).

Studies were undertaken to confirm the ionic nature of the radioinduced polymerization of butadiene and to examine the effects of added materials on rate and structure. The microstructure of a typical −78°C polybutadiene was determined by the infrared method. The conversion per unit dose at −78°C was found to be 0.33% per megarad. From 0 to 7 megarad the conversion rate appeared to vary as the first power of the dose rate. Free radicals from azobisisobutyronitrile did not cause detectable polymerization at −78°C. At least 20% of the polymer was found to consist of conjugated vinyl groups and saturated structures. Irradiation of a butadiene solution saturated with naphthalene led to no detectable polymer. Heptane did not change the rate beyond experimental error. Carbon tetrachloride caused the rate to double. Chloroform increased the rate 1.8 fold, methylene increased it 2.0 fold, methyl iodide reduced it 23%, and carbon disulfide increased the rate 1.5 fold. (auth)

**4576** (TID-7643(p.118-26)) THE RADIATION-INDUCED POLYMERIZATION OF CYCLOPENTADIENE AT −78 C. William R. Busler and Ffrancon Williams (Tennessee. Univ., Knoxville).

A diagnostic test was made of the ionic mechanism of radioinduced polymerization by an evaluation of the effect of ammonia on the polymerization of cyclopentadiene at −78°C. After a dose of approximately $6.0 \times 10^{17}$ $erg^{-1}$, corresponding to 2.0% conversion to polymer, gel formation was apparent. The yield of polymer was fairly linear with irradiation dose up to about 20% conversion. Complete conversion of the cyclopentadiene monomer to polymer was effected at doses of the order of $10^{20}$ $erg^{-1}$. Ammonia reduced the polymerization yield. The results were consistent with an ionic mechanism for the radioinduced polymerization of cyclopentadiene. (M.C.G.)

**4577** (TID-7643(p.127-35)) EFFECT OF OXYGEN ON RADIATION POLYMERIZATION IN SOLID SOLUTIONS OF ACRYLAMIDE-PROPIONAMIDE. G. Adler (Brookhaven National Lab., Upton, N. Y.).

It was shown that oxygen has very little effect on the solid state polymerization of acrylamide. Evidence from electron spin resonance indicates that oxygen cannot diffuse into acrylamide. Polymerization occurs in solid solutions with low concentrations of acrylamide and it is shown that oxygen diffuses into the lattice. The effect of oxygen on the polymerization is described. The mechanism of the oxygen-polymer reaction is discussed in the light of the known crystal structures and its implications for scavenger work in the solid state are drawn. (auth)

**4578** (TID-7643(p.136-49)) RADIATION INITIATED POLYMERIZATION IN THE SOLID STATE. Adolphe Chapiro (France. Centre National de la Recherche Scientifique. Laboratorie de Chemie des Radiations, Bellevue).

Data on the radioinduced polymerization of monomers in the solid state are reviewed. Monomers examined are classified according to their kinetic behavior. Five groups of systems can be defined on the basis of the shape of the Arrhenius diagram near the melting point. The radioinduced polymerization of styrene, acrylonitrile, 3,3 bis(chloromethyl) oxetane, methyl methacrylate, methyl acrylate, vinyl pyrrolidone solids were studied. (M.C.G.)

**4579** (TID-7643(p.150-77)) THE MECHANISMS OF RADIATION INDUCED SOLID STATE POLYMERIZATION OF CYCLIC MONOMERS. K. Hayashi and S. Okamura (Japanese Assn. for Radiation Research on Polymers. Osaka Labs., Osaka).

The mechanisms of radiation-induced solid-state polymerization of cyclic monomers such as trioxane, β-propiolactone, and 3,3 bis(chloromethyl) oxetane were investigated. These monomers polymerized only in solid state and gave crystalline polymers well oriented in three dimensions. The rate of polymerization was influenced very much by the crystalline state of monomers. In following the polymerization reaction by means of x-ray-diffraction analysis, it was observed that the polymerization reaction proceeded along a fixed axis according to epitaxy with the crystalline structure of monomer. Such polymerization is designated as "topotactic polymerization." The rate of polymerization of single crystalline trioxane was dependent upon the irradiation direction. The initiation mechanisms were studied using methods of mass spectrometry, radiation thermoluminescence and electron spin resonance. About twenty derivatives of 3,3 bis(chloromethyl) oxetane were polymerized in order to study the effects of substituents on the polymerizability in solid state. Then it become obvious that polymerization occurred only in substituent having the suitable magnitude and polarity. That is, solid state polymerization of oxetanes were controlled by the crystalline lattice structure of monomer. The rate of polymerization of cyclic monomers had the maximum value at the temperature just below the melting point and decreased suddenly at phase transition points of the crystals which were estimated by nuclear magnetic resonance, infrared spectrometry, and thermal differential analysis methods. On the basis of these results, it was concluded that considerable motion of monomer molecule or substituent around the lattice point of crystal was necessary for solid-state polymerization. In addition, it is suggested that energy transfer and molecular interaction in the crystalline phase may play an important role in the polymerization process. (auth)

**4580** (TID-7643(p.185-98)) GRAFTING OF VINYL PYRROLIDONE TO POLYMETHYLMETHACRYLATE BY PRE-IRRADIATION TECHNIQUES. I. PEROXIDE-INITIATION. R. Lieberman, R. A. Markle, F. A. Sliemers, J. F. Kircher, and R. I. Leininger ([Battelle Memorial Inst., Columbus, Ohio]).

Grafting of vinyl pyrrolidone to peroxidized polymethylmethacrylate is described. The effects on grafting of several variables associated with the irradiation peroxidation are discussed. The use of low total irradiation doses, low dose rates, and high irradiation temperatures are shown to favor, independently, the formation of peroxidized structures which upon subsequent reaction with vinyl pyrrolidone form crosslinked copolymers. A mechanism is proposed for the peroxidation reaction which suggests that more than one type of peroxy site is formed. Resultant grafting results are explained in terms of the different activities and stabilities of these peroxides. (auth)

**4581** (TID-7643(p.200-18)) ESR STUDIES OF THE DECAY OF FREE RADICALS IN IRRADIATED POLYETHYLENE. Malcolm Dole and Francis Cracco (Northwestern Univ., Evanston, Ill.).

Experiments were carried out to study the decay of free radicals in irradiated polyethylene at different temperatures. A high-density polyethylene was irradiated at liquid nitrogen temperature and the concentration of electron spins measured. Hydrogen was evolved on warming to 180 to 200°K. It was determined that free radical decay did not begin until the temperature reached a value of about 155°K. The free radicals had half decayed at about 180°K. (M.C.G.)

**4582** (TID-7643(p.219-32)) KINETIC FEATURES OF GRAFT COPOLYMERIZATION WITH SPECIAL REFERENCE TO RADIATION GRAFTING. Adolphe Chapiro (France. Centre National de la Recherche Scientifique. Laboratoire de Chemie des Radiations, Bellevue).

The various methods that can lead to graft copolymers are discussed. Diffusion and gel effects in graft copolymerization are described along with the coalescence effect caused by the incompatibility of polymers. Special features of radiation grafting are listed. References are given for detailed studies. (M.C.G.)

**4583** (TID-7643(p.233-44)) ACCELERATIVE EFFECTS IN RADIATION-INDUCED GRAFT POLYMERIZATION. George Odian and Terese Ellen Acker (Radiation Applications Inc., Long Island City, N. Y.).

The use of methanol was found to increase the rate of radioinduced grafting in the systems polyethylene–styrene, nylon–styrene, polypropylene–styrene, polyvinylchloride–styrene, polyethylene–methyl acrylate, nylon–methyl acrylate, and teflon–TFE–methyl acrylate. It was found that n-hexane acts in the same manner in the system polyethylene-t-butylaminoethyl methacrylate. The mechanisms of these accelerated effects were attributed to the incursion of a Trommsdorff-type effect on an increase in monomer concentration due to solvent swelling of the polymer. Calculations are given for the kinetic parameters. (M.C.G.)

**4584** (TID-7643(p.245-58)) RADIATION CROSSLINKING OF POLYMERS VIA POLYFUNCTIONAL MONOMERS. George Odian and Bruce S. Bernstein (Radiation Applications Inc., Long Island City, N. Y.).

Results are presented on the crosslinking of polyethylene, polypropylene, and polyisobutylene. Various monomers were screened as to their efficiency in the crosslinking of polyethylene via the polyfunctional monomer-crosslinking technique. Allyl methacrylate and allyl acrylate, which were found to be two of the more efficient monomers, were studied more extensively. The dose required to produce a 50% gel content in polyethylene was approximately 1.5 Mrads for the monomer crosslinking technique as compared to 11 Mrads for the straight radiation technique. The high-temperature properties and tensile strength of all three polymers were improved by monomer crosslinking. In polypropylene a 60% gel was obtained at approximately 3 Mrads using allyl methacrylate whereas monomer-free polypropylene did not give a gel at this dosage. Polyisobutylene, which does not crosslink on straight irradiation, yielded a gel content of approximately 60% after 1 Mrad of radiation using 15% allyl acrylate. (M.C.G.)

**4585** (TID-7643(p.259-67)) RADIATION INDUCED GRAFTING TO CELLULOSE AND ITS DERIVATIVES. V. Stannett (Research Triangle Inst. Camille Dreyfus Lab., Durham, N. C.).

Studies were made of radioinduced grafting to cellulose and its derivatives. Separation studies were carried out on a number of cellulosic graft copolymers. It was found that the grafting yield per megarad drops off rapidly with increasing dose rate, the actual rate of grafting being roughly independent of dose rate. The monomers exerted a strong protective action against degradation of the cellulose under radiation. (M.C.G.)

**4586** (TID-7643(p.268-99)) MODIFICATION OF TEXTILE FIBER PROPERTIES BY RADIATION-INDUCED GRAFT POLYMERIZATION. PART I. THE APPLICATION OF VINYL MONOMERS BY A VAPOR-PHASE TECHNIQUE. Arthur A. Armstrong, Jr. and Henry A. Rutherford (North Carolina State Coll., Raleigh. School of Textiles).

The vapor-phase process for grafting vinyl monomers to cellulose and other fibers, some of the conditions that tend to accelerate grafting, and some of the properties of grafted fibers are discussed. Acrylonitrile was found to be the only monomer that significantly improved some of the physical properties. The presence of water greatly accelerated the addition of monomers to textile fibers. Rates of grafting are shown in graphs. (M.C.G.)

**4587** (TID-7643(p.300-18)) MODIFICATION OF TEXTILE FIBER PROPERTIES BY RADIATION-INDUCED GRAFT POLYMERIZATION. PART II. DIFFUSION AND KINETICS IN RADIATION-INDUCED GRAFT POLYMERIZATION. Arthur A. Armstrong, Jr. (North Carolina State Coll., Raleigh. School of Textiles).

An investigation was made of diffusion and kinetics in radioinduced vapor-phase graft polymerization. A mechanism is proposed for the post-irradiation process. Equations are presented for a model that agrees with the data. (M.C.G.)

**4588** (TID-7643(p.319-34)) RADIATION-INDUCED GRAFT POLYMERS OF CELLULOSE. Jett C. Arthur, Jr. and Florine A. Blouin (Department of Agriculture. Southern Regional Research Lab., New Orleans).

The radiation chemistry of cotton cellulose, graft polymerization reactions of irradiated cellulose, and the properties of the graft polymers of cellulose are being investigated. The major molecular changes which occurred on irradiation of cellulose were depolymerization and formation of acid and reducing groups. The crystalline-amorphous nature of the cellulose structure was apparently not changed by high-energy radiation. Mass spectrometry indicated complete reaction of oxygen present in an air atmosphere and almost complete reaction of an oxygen atmosphere with the activated cellulose at the dosages investigated. With increasing radiation dosage the solubility of degradation products in water and dilute sodium hydroxide increased. It was demonstrated that irradiated cotton cellulose has base exchange properties. A mechanism was developed to explain the interaction of radiation with cellulose. The graft polymerization reactions of acrylonitrile-cellulose, styrene-cellulose, and acrylonitrile-cyanoethylated cellulose were evaluated. Graft polymerization caused decreased stiffness of the yarns, increased elongation-at-break, decreased breaking toughness, decreased breaking strength, and increased yarn number. The graft polymers were thermoplastic. (M.C.G.)

**4589** (TID-7643(p.335-44)) PREPARATION OF WOOD-PLASTIC COMBINATIONS USING GAMMA RADIATION TO INDUCE POLYMERIZATION. J. A. Kent, A. W. Winston, W. R. Boyle, and L. W. Harmison (West Virginia. Univ., Morgantown).

Evaluations are being made of the properties of modified wood prepared by *in situ* radioinduced polymerization of monomers impregnated throughout the wood. The rates of *in situ* polymerization are being studied to determine the minimum dose requirements for various combinations. Conversion curves for the polymerization of methyl methacrylate and ethyl acrylate. Work with white pine, white oak, and other species is in progress. The preliminary data indicate that marked improvements in many properties can be expected. (M.C.G.)

**4590** (TID-7643(p.345-97)) GRAFTING OF CHLOROMETHYLSTYRENE TO POLYPROPYLENE FIBERS BY THE USE OF IONIZING RADIATION. R. F. Stamm, E. F. Hosterman, C. D. Felton, and Catherine S. Hsia Chen (American Cyanamid Co. Central Research Div., Stamford, Conn.).

Chloromethylstyrene monomer was grafted to 3 denier (pre-formed) polypropylene fibers by using ionizing radiation. At elevated temperatures, microscopic investigations of changes in diameter and in birefringence demonstrated that this monomer swells the fibers without dissolving them. Thus, it is comparatively simple to achieve grafting all the way to the center. Such grafted fibers can be dyed by direct or acid dyes in non-aqueous baths (e.g., dimethylformamide at 120°C) using levels of graft of ~25% by weight. This leads to covalent bonding arising from reaction between the dye and the benzyl chloride group of the graft. Dyeing in standard aqueous baths can also be achieved at even lower levels of graft (less than 10% by weight) if the grafted material is treated with a nucleophilic reagent such as pyridine. Using thin cross-sections of treated fibers, photomicrographs were taken with monochromatic uv radiation, and with visible light on color film. These, combined with electron micrographs of much thinner cross-sections provide pictorial proof of the complete penetration of the graft and of the dyes as well as showing the opening up of the structure effected by grafting. By the means employed, it was possible to achieve marked improvements in dyeability, sticking temperature, moisture regain, and antistatic behavior without diminishing the excellent mechanical properties of the polypropylene fibers. (auth)

**4591** (TID-7643(p.398-413)) GRAFT COPOLYMERS OF POLYETHYLENE AND ACRYLIC ACID. James K. Rieke (Dow Chemical Co. C. C. Kennedy Research Lab., Midland, Mich.).

Pre-irradiation techniques for the graft copolymerization of polyethylene and acrylic acid are described. The data suggested that a fairly definite radiation threshold exists and that radiation doses above the threshold value are largely ineffective in increasing the yield. The composition of the copolymer was directly proportional to the acrylic acid concentration. There was almost complete independence of grafting on the amount of diluent used. In general the properties of the graft copolymers are substantially those of the parent polyethylene. The polarity introduced into polyethylene by the grafting of acrylic acid markedly improved the ability of the material to adhere to most high energy surfaces such as metals. (M.C.G.)

**4592** (TID-14927) KINETICS FOR THE RADIATION INDUCED REACTIONS OF METHYLENE BLUE IN AQUEOUS SOLUTIONS. Irving Auerbach (Sandia Corp., Albuquerque, N. Mex.). [Jan. 16, 1962]. Contract [AT(29-1)-789]. 25p. ([SCDC-2553])

The effects of aeration, deaeration, hydrogen, 0.2$\underline{M}$ sodium benzoate, and 0.4$\underline{M}$ ethanol on the kinetics of the x-ray-induced reactions of methylene blue were analyzed. Data from Day and Stein were used. The reaction orders for the aerated and deaerated experiments are one-half. In the presence of hydrogen, the apparent reaction order is three-halves. Kinetic expressions were derived from a model reaction scheme in which a dimer of the dye or one of its reduction intermediates is in equilibrium with a monomer intermediate. The rate-determining step which involves reduction of the monomer to the leuco base is one-half order with respect to the dye. The rate constant differences for the aerated and deaerated solutions are due to a reverse reaction which takes place in the presence of oxidizing agents. In the presence of hydrogen and the absence of the reverse reaction, the rate determining step involves largely the dissociation of the dimer and should be second order. The observed apparent three-halves order rather than second order kinetics is due possibly to residual radiation-formed oxidizing agents which are not removed by hydrogen and/or monomer constituents. In the presence of sodium benzoate, the reaction kinetics are zero order. Derived kinetic expressions indicate that the reaction is dependent on the steady state concentrations of the water radiation products and the benzoate ion-radical. In the presence of ethanol the kinetics are between one-half and zero order because of the greater instability of the $\cdot C_2H_4OH$ radical in comparison with the benzoate ion-radical. (auth)

**4593** (TID-17266) RADIATION-INDUCED CYANOGENATION OF ORGANIC-COMPOUNDS. Quarterly Technical Status Report No. 8, July 1, 1962 to September 30, 1962. James A. Knight, Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(38-1)-202. 12p.

The major emphasis was on the determination of radiolytic gases from irradiated cyanogen–cyclohexane mixtures and on the problem of the decrease in the amount of cyclohexyl cyanide in the irradiated mixture with increasing time after irradiation. The major radiolytic gases are hydrogen, $G \sim 3.4$, and hydrogen cyanide, $G \sim 2.4$, for dose of $2.44 \times 10^{20}$ ev/g. It was found that treatment of the irradiated mixture with either 5% potassium hydroxide solution or potassium hydroxide pellets immediately after irradiation prevents a decrease in the amount of cyclohexyl cyanide. Also, the G values for cyclohexyl cyanide for the base-treated irradiated mixtures are in the range of 18 to 20 for mixtures irradiated to a dose of $2.44 \times 10^{20}$ ev/g. (auth)

**4594** CALCULATIONS OF IRRADIATED SPECIMEN ACTIVITY DURING PERIODICALLY STOPPED REACTOR OPERATIONS. G. Fodor (Inst. of Nuclear Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 275-82(1962). (In Rumanian)

Formulas were developed for precisely calculating the final radioisotopic activities induced by irradiation in a periodically operating reactor. (tr-auth)

**4595** CHEMICAL EFFECTS ASSOCIATED WITH RADIOACTIVE THERMAL NEUTRON CAPTURE IN BICHROMATES. E. Găinar and I. Găinar (Inst. of Nuclear Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 309-18(1962). (In Rumanian)

Chemical stabilization of $Cr^{51}$ in aqueous solutions of dichromate irradiated by thermal neutrons was investigated. Anion exchange was used for separating $Cr_2O_7^{2-}$, $CrO_4^{2-}$, and other ions. Specimens of ammonium dichromate were annealed and the rate and energy of active processes participating in the recoil fragment annealing were determined. (tr-auth)

**4596** RADIATION INDUCED POLMERIZATION OF SOME VINYL MONOMERS IN EMULSION SYSTEMS. Dieter Hummel, Gregor Ley, and Christel Schneider (Universität Cologne). Advan. Chem. Ser., 34: 60-86(1962).

Aqueous emulsions of styrene, methyl methacrylate, methyl acrylate, and ethyl acrylate were polymerized with $\gamma$ radiation from a $Co^{60}$ source in the presence of sodium dodecyl sulfate or sodium laurate. The continuous measurement of conversion and reaction rate was carried out dilatometrically. The acrylates polymerized fastest and the overall polymerization rate increased as follows: styrene < methyl methacrylate < ethyl acrylate < methyl acrylate. The effects of radiation dose, temperature, and original monomer and emulsifier concentrations were studied with respect to the following factors: properties of polymer dispersions, number and size of polymer particles, viscometrically determined molecular weights, monomer-water ratio, and kinetic constants. (auth)

**4597** OXIDATION YIELD IN FRICKE DOSIMETRY OF $P^{32}$ BETA RADIATION. A. M. Baptista and J. Gomes da Silva (Centro de Fisica, Lisbon and Instituto Portugues de Oncologia, Lisbon). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 58: 165-70(May-June 1962). (In Portuguese)

A determination was made of the G-value, the number of ions formed by the absorption of 100 ev of energy, in the ferrous sulfate dosimetry of $P^{32}$ beta particles. The value obtained was: $G = 15.6 \pm 0.07$. A discussion is included of the errors which may possibly affect the results. (tr-auth)

**4598** KINETICS AND MECHANISM OF OXIDATION OF THE $I^-$ IONS UNDER THE INFLUENCE OF $^{60}Co$ RAYS. B. Jeżowska-Trzebiatowska, J. Kaleciński, and W. Jedrzejewski (Univ. of Wrocław, Poland and Inst. of Physical Chemistry, Wroclaw Branch, Polish Academy of Sciences). Bull. Acad. Polon. Sci., Ser. Sci., Chim., 10: 367-72(1962). (In English)

The yield $G(I_2)$ was studied in alkaline solutions in order to establish the mechanism of $I^-$ oxidation under equilibrium conditions. The results show that the $I_2$ concentration increases with time of exposure and initial $I^-$ concentration and decreases with pH, whereas $G(I_2)$ decreases with exposure time. A mechanism in which OH radicals function as both reducing oxidizing magnets is proposed: $I^- + OH \rightarrow I + OH^-$, $2I + 2OH^- \rightarrow IO^- + I^- + H_2O$, $IO^- + OH \rightarrow I + HO_2^-$, $IO^- + HO_2^- \rightarrow I^- + OH^- + O_2$, $2I^- + H_2O_2 \rightarrow I_2 + 2OH^-$, and $I_2 + 2H \rightarrow 2I^- + 2H^+$. (D.L.C.)

**4599** RADIATION CHEMISTRY OF CARBOHYDRATES. PART XI. SELF-DECOMPOSITION OF D-[$^{14}$C]MANNOSE, D-[$^{14}$C]RIBOSE, AND D-[$^{14}$C]FRUCTOSE. G. O. Phillips, W. J. Criddle, and G. J. Moody (University Coll., Cardiff, S. Wales). J. Chem. Soc., 4216-24(Oct. 1962).

Paper-chromatographic and isotope-dilution analysis showed that considerable decomposition of D-[C$^{14}$]mannose, D-[C$^{14}$]ribose, and D-[C$^{14}$]-fructose occurred when these sugars were stored in vacuo in the freeze-dried state. The relative contributions to the decomposition of primary and secondary radiation effects are discussed. The results indicate that non-bonded water, retained by the sample after freeze-drying, may be responsible for most of the degradation, this being due to formation of hydrogen atoms and hydroxyl radicals by radiation. Storage of D-[C$^{14}$]mannose in frozen dilute aqueous solution reduces the decomposition significantly and indicates a possible method of storing C$^{14}$-labeled carbohydrates of high specific activity for long periods. (auth)

**4600** MECHANISM AND KINETICS OF THE OXIDATION OF IRON(II) IONS AND ACETONE IN AQUEOUS SOLUTION BY $\gamma$ RADIATION. B. Chutný (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 27: 1877-85(Aug. 1962). (In German)

The radiochemical oxidation of $Fe^{2+}$ ions and acetone in aqueous 0.8N $H_2SO_4$ by $\gamma$ radiation in the presence of oxygen was investigated. The oxidation proceeds by the Kolthoff mechanism which is supplemented by the reaction of acetone with hydrogen atoms. The velocity constant of the reaction OH radicals with acetone was determined with the Fenton reaction. The theoretical yield of $Fe^{3+}$ calculated from the kinetic equation shows, in the region of low acetone concentration, good agreement with the measured values. (tr-auth)

**4601** RARE-GAS SENSITIZED RADIOLYSIS OF PROPANE. Jean H. Futrell and Thomas O. Tiernan (Aeronautical Research Labs., Wright-Patterson AFB, Ohio). J. Chem. Phys., 37: 1694-9(Oct. 15, 1962).

The radiolysis of mixtures of $C_3H_8$ and nitric oxide containing excess amounts of the rare gases Xe, Kr, Ar, and He, and of equimolar amounts of $C_3H_8-C_3D_8$ in the same mixtures was investigated. The product yields were compared with those expected assuming that the primary process leading to decomposition of the hydrocarbon is charge exchange with the appropriate noble gas, followed by ion-molecule reactions of the hydride-transfer type. The experiments with deuterated propane demonstrated the formation of ethane and acetylene in bimolecular processes, and the production of methane, ethylene, and propylene chiefly by unimolecular decomposition. If it is assumed that neutralization of propyl ions results in the formation of ethylene and propylene as molecular products, the observations are consistent with the reaction sequence charge transfer, ion–molecule reactions, and neutralization leading to the production of unscavengeable species. (auth)

**4602** YIELD AND REACTIVITY OF ELECTRONS AND H ATOMS IN IRRADIATED AQUEOUS SOLUTIONS. Joseph Rabani and Gabriel Stein (Hebrew Univ., Jerusalem). J. Chem. Phys., 37: 1865-73(Oct. 15, 1962).

Using specific scavengers of solvated electrons $e^-_{aq}$, and of atomic hydrogen H in aqueous solutions x irradiated, evidence was obtained that the hydrogen yield $G_{hydrogen}$ = 3.7 ± 0.1 between pH 2–4. It is shown that the yield corresponds to the sum of the yields of molecular hydrogen $G_{H_2}$ = 0.5, the primary yield of atomic hydrogen $G_H = 0.55$, and yield of solvated electrons $G_{e^-_{aq}} = 2.65$. Evidence was also obtained showing that H atoms formed as such ($G_H = 0.55$) appear in the bulk of the solution even at neutral pH. The velocity constants of the reactions of H atoms with acetate, isopropanol, glucose, glycerol, and nitrite were obtained. The reactivity of $e^-_{aq}$ with $H^+_{aq}$, acetone and ferricyanide was studied and relative velocity constants obtained. An upper limit, $k_{e^-_{aq}+H_2O} \leq 10^3$ liter mole$^{-1}$ sec$^{-1}$ was found for the reaction of $\bar{e}_{aq}$ with water to yield hydrogen. (auth)

**4603** RETENTION OF F$^{18}$ PRODUCED BY THE F$^{19}$(n,2n) REACTION IN FLUORO-ORGANIC COMPOUNDS. M. Anbar and P. Neta (Weizmann Inst. of Science and IAEC Research Labs., Rehovoth, Israel). J. Chem. Phys., 37: 1877-8(Oct. 15, 1962).

The retention of F$^{18}$ in fluoroaromatic compounds in solution is reported. Samples of solutions of p-fluorobenzoic acid in water and in acetic acid, as well as of fluorobenzene and p-fluorotoluene in ethanol were irradiated at a flux of $7 \times 10^{11}$ n/cm$^2$/sec. The labeling yields of all three fluoroaromatic compounds tested were equal and independent of concentration throughout the range presented. It was not affected by the presence of formic acid, a powerful free-radical scavenger. Also, the same labeling yield was obtained in all three solvents–water, acetic acid, and ethanol. It is suggested that the (n,2n) reaction proceeds, in part at least, as a spallation reaction, leaving the transformed nucleus almost intact. (P.C.H.)

**4604** ESR SPECTRUM OF ELECTRON IRRADIATED CYCLOHEPTATRIENE. CYCLOHEPTATRIENYL RADICAL. S. Arai (Tokyo Inst. of Tech.), S. Shida, K. Yamaguchi, and Z. Kuri. J. Chem. Phys., 37: 1885-6(Oct. 15, 1962).

Electron spin resonance measurements on irradiated cycloheptatriene were made to obtain information on the cycloheptatrienyl radical formed. The spectrum of equally spaced eight lines was attributed to the hyperfine interaction of the seven equivalent protons, and it was concluded that the unpaired electron density on each carbon atom was one-seventy of an odd electron. It was concluded that cycloheptatrienyl radical may have a symmetric conjugated plane frame, that is, the greatly increased resonance energy in the new frame is sufficiently large to overcome the strain required to flatten the ring. Q was found to be −27 G. It was also found that cycloheptatriene has the excited state with a definite lifetime, which is capable of the isomerization or collisional deactivation. (P.C.H.)

**4605** EFFECT OF LIQUID-SOLID PHASE TRANSITION UPON THE YIELD OF HYDROGEN FROM BIPHENYL, BIPHENYL-d$_{10}$, AND MIXTURES OF THESE TWO SUBSTANCES. J. M. Scarborough and J. G. Burr (North American Aviation Science Center, Canoga Park, Calif.). J. Chem. Phys., 37: 1890-1(Oct. 15, 1962).

An estimate of the relative importance of the unimolecular and bimolecular processes in hydrogen formation was secured by radiolysis of biphenyl and deuterated biphenyls in the solid phase. Solid biphenyl samples of 8-10 g size were irradiated to a total dose of about $4 \times 10^{21}$ ev/g. The sharp drop in hydrogen yield which accompanied the phase change suggested that the processes responsible for the production of hydrogen in the radiolysis of biphenyl were severely hampered by immobilization of biphenyl molecules in a solid matrix. The possibility that the HD formed from the solid mixture of biphenyl and biphenyl-d$_{10}$ might have resulted from the secondary reactions of some active species freed during the melting process was eliminated by the observation that the isotopic composition of the hydrogen was the same for the hydrogen obtained by sublimation or by melting of the irradiated biphenyls. (P.C.H.)

**4606** KINETIC STUDIES OF THE PHOTOCHEMICAL REDUCTION OF URANYL SULFATE IN THE PRESENCE OF ALPHA-HYDROXY ISO-BUTYRIC ACID. [PART] I. Kuan Pan and Wen-Kuei Wong (National Taiwan Univ., China). J. Chinese Chem. Soc. (Taiwan), 8: 1-13(Mar. 1, 1961). (In English)

The photochemical reduction of U(VI) to U(IV) sulfate in the presence of $\alpha$-hydroxy iso-butyric acid, accompanied with the decarboxylation and oxidation of the acid to acetone was observed. The reaction rate was found to be of the fourth order, or of the pseudo first-order with respect to the U(VI) ion concentration in an excess of the acid by following spectrophotometrically the concentration of U(IV) ion produced. A fourth-order rate equation was derived. (auth)

**4607** GRAFT POLYMERIZATION OF ACRYLONITRILE ON POLYETHYLENE AND POLYPROPYLENE BY PRE-IRRADIATION IN A VACUUM. Masatoshi Miura and Shunzi Kawamatsu. Kobunishi Kagaku, 19: 175-80(Mar. 1962).

Test results of the temperature effects and the relationship between the pre-irradiation dosage and the grafting ratio on the graft polymerization induced by adding the monomer to the polyethylene film, irradiated in a vacuum, are discussed. A 1500-c $Co^{60}$ $\gamma$-ray source was used. Pre-irradiation dosages up to 10 Mrep at the rate of $1.2 \times 10^5$ rep/hr in the temperature range of 0 to 105°C were used. The grafting ratio (wt-%) increased randomly or proportionally for low or high density samples, respectively, with respect to temperature. It was concluded that the grafting ratio was proportional to the concentration of the trapped free radicals in the irradiated polyethylene. The long lifetime free radical concentration increased with dosage for a wide range of irradiation times but was inactive at low grafting temperatures. However, the short lifetime free radical concentration became constant above a certain irradiation dosage and was reactive at low temperatures. The grafting ratio decreased with increasing time elapsing before the addition of the monomer after irradiation and was more pronounced at higher grafting temperatures. (OID)

**4608** GAMMA-RAY-INDUCED GRAFT COPOLYMERIZATION. IV. GRAFT COPOLYMERIZATION OF METHACRYLIC ACID TO POLYETHYLENE BY THE MUTUAL GRAFT TECHNIQUE. Tasuo Matsuda. Kobunshi Kagaku, 19: 267-75(Apr. 1962).

Samples were prepared by irradiating a polyethylene (PE) film immersed in a methanol solution of methacrylic acid, at 25 ± 1°C with $Co^{60}$ $\gamma$-rays from a 300 or 3000-c source facility. Photomicrographs of cross sections showed that initial grafting occurred predominately at the surface. The grafted layer served as a matrix for further grafting. An analysis of the products (the monomer concentration, dosage rate, and film thickness were 0.75 mol/l, $7.4 \times 10^4$ r/hr, and 0.07 mm, respectively). The grafted PE weight plotted against time increased almost linearly. The effects of factors, such as film thickness (0.03, 0.05, or 0.07 mm), monomer concentration (0.25 to 2.5 mol/l), dosage rate ($1.4 \times 10^4 \sim 5.5 \times 10^5$ r/hr), amount of solvent, and the initial grafting rate on graft copolymerization are discussed briefly. It was observed that the amount of polymethacrylic acid grafted in benzene–methanol was greater than that in methanol. The grafted methacrylic acid increased with the electric surface resistance of the PE film. (OID)

**4609** RADIATION-INDUCED POLYMERIZATION BY TRIPLE BONDS. Seizo Okamura. Kogyo Kagaku Zasshi, 65: 728-31(May 1962).

The mechanism of radioinduced polymerization of monomers with triple bonds, such as acetonitrile, propargyl bromide, propargyl alcohol, and phenylacetylene was studied. The samples were gamma irradiated with a 1000-c $Co^{60}$ source under a pressure of $10^{-4}$ mm Hg at temperatures ranging from 23 to −196°C. The rate of polymerization is proportional to the first order of the dosage rate and is not affected by the presence of air. The activation energy is very low (0.3 kcal/mol in the case of propargyl bromide). From a comparison of the results of radical, cationic, and anionic polymerization, it was concluded that the polymerization of acetonitrile proceeded in an anionic mechanism. The mechanism of the others was not clear. Small G-values (10 ~ 50) and degrees of polymerization (10 ~ 50) were observed. The induced polymers appeared in a dark brown color and had conjugated double bonds. (OID)

**4610** RADIATION-INDUCED LIQUID- AND SOLID-PHASE POLYMERIZATION OF ACETYLENE. Yoneho Tabata. Kogyo Kagaku Zasshi, 65: 731-4(May 1962).

Polymerization of both solid and liquid acetylene monomers induced by means of $Co^{60}$ $\gamma$ rays at the rate of $3 \times 10^4 \sim 10^5$ r/hr at −196°C and under a pressure of $10^{-2} \sim 10^{-3}$ mm/Hg was studied. Results indicated that the liquid phase polymerization proceeds by a cationic mechanism for polymers mainly in the cis- form. In the solid phase, the trans- form dominates. Therefore, a new mechanism, electronic polymerization, is proposed for solid state polymerization at low temperatures. (OID)

**4611** RADIATION-INDUCED POLYMERIZATION OF CRYSTALLINE COPOLYMERS. Yoneho Tabata, Hiroshi Shibano, and Hiroshi Sobue. Kogyo Kagaku Zasshi, 65: 737-40(May 1962).

The radical mechanism of the radioinduced copolymerization of tetrafluoroethylene with ethylene by means of a $Co^{60}$ $\gamma$-ray source is described. The x-ray diffraction measurements indicated that the copolymer was crystalline. The observed varying compositions and melting points of the copolymers with respect to molar concentrations and components of one of the monomers are discussed. It was concluded that polymerization is important both for the energy transfer to ethylene from tetrafluoroethylene and for the great affinity of the hydrogen atom for the fluorine atom. (OID)

**4612** RADIATION-INDUCED POLYMERIZATION OF ACRYLONITRILE IN LIQUID ETHYLENE. Yoneho Tabata, Hiroshi Sobue, and Akira Hara. Kogyo Kagaku Zasshi, 65: 735-7(May 1962).

The mixed system of 2 unsaturated compounds were irradiated by $Co^{60}$ $\gamma$-rays at −78°C at the rate of $7 \times 10^4$ r/hr up to $6.4 \times 10^6$ r. Only acrylonitrile polymerized. The results indicated that both $C=C$ and $C\equiv N$ bonds of acrylonitrile polymerized; however, the ratio of the 2 types varied with different concentrations of the monomer. Polymerization of the former occurred only in a bulk 100% monomer, while the latter occurred predominantly in a dilute monomer solution. This type of polymerization, $C\equiv N$, would be an ionic mechanism, and probably anionic. It was concluded that polymerization of such a mixture was partially by the ionic mechanism in medium concentration of the monomer. The structures of the products are described. (OID)

**4613** RADIATION-INDUCED COPOLYMERIZATION OF ALKYLENE OXIDE AND ACRYLONITRILE. Seizo Okamura, Koichiro Hayashi, and Haruhiko Watanabe. Kogyo Kagaku Zasshi, 65: 740-2(May 1962).

Results obtained on the radioinduced polymerization of ethylene oxide and propylene oxide mixed with acrylonitrile showed that at room temperature, a high content of the homopolymer of acrylonitrile is obtained, but as the temperature decreased, it decreased with increasing content of the alkylene oxide copolymer. The copolymer content of the oxide became highest at –196°C. It was concluded that polymerization occurred without the production of a mixture of 2 homopolymers. (OID)

**4614** THE EFFECT OF pH ON THE RADICAL YIELDS IN THE $\gamma$-RADIOLYSIS OF AQUEOUS SYSTEMS. F. S. Dainton and W. S. Watt (Univ. of Leeds, Eng.). Nature, 195: 1294-6(Sept. 29, 1962).

**4615** EPR STUDY OF THE PROPERTIES OF HYDROGEN ATOMS FORMED IN SILICA GEL BY $\gamma$-IRRADIATION. V. B. Kazanskii, G. B. Pariiskii, and A. I. Burshtein. Opt. Spectry. (USSR) (English Transl.), 13: 45-9(July 1962).

Measurements were made of the spin-lattice relaxation time $T_1$ of hydrogen atoms formed by $\gamma$-irradiation of silica gel from its surface hydroxyl groups or molecules of water adsorbed on its surface. The influence of the paramagnetic molecules of oxygen on $T_1$ was also studied. It is shown that hydrogen atoms are stabilized on the surface and in voids in the crystalline lattice of the surface layer of this substance. (auth)

**4616** RADIOACTIVE PHOSPHORUS $P^{32}$. Olga Jovanović-Kovačević. Tehnika, 17: 1041-4(1962).

Possibilities of application and the production of $P^{32}$ are discussed. Characteristics are given for $P^{32}$ produced in a hot lab, and shielding for $\beta$ and x rays is discussed. (OID)

**4617** RADIOLYSIS OF LIQUID PROPYLENE: ION-MOLECULE CONDENSATION. C. D. Wagner (Shell Development Co., Emeryville, Calif.). Tetrahedron, 14: 164-7 (1961).

Radiolysis of propylene gives mainly hydrogen, and dimeric, trimeric, and other low molecular weight polymeric hydrocarbons. Detailed analysis of the dimer shows the products to be, in order of concentration, 4-methyl-1-pentene, 1,5-hexadiene, 1-hexene, 2-methylpentane, 2,3-dimethylbutane, 4-methyl-2-pentene, 2-methyl-1-pentene, 2-hexene, and n-hexane. The relative product concentrations, and the isotope species distribution in the products obtained from radiolysis of a 50 : 50 mixture of propylene and propylene-$d_6$, demonstrate that the alkanes, the diene, and much of the olefinic products are formed by combinations of n-propyl, isopropyl, and allyl radicals. Isotopic species distributions in 4-methyl-1-pentene, 1-hexene, and 2-hexene demonstrate that appreciable fractions of each of these products are formed by a direct condensation of two propylene molecules with intramolecular hydrogen rearrangement. The previously postulated direct dimerization is thus verified, and the idea of its being an ion-molecule condensation receives further support. (auth)

**4618** THE EFFECT OF THE DNA MACROSTRUCTURE ON THE X-RAY-INDUCED EXTINCTION MODIFICATION IN THE REGION BETWEEN 210 AND 350 nm. L. Rossberg (Max-Planck-Institut für Biophysik, Frankfurt am Main). Z. Naturforsch., 17b: 548-52(Aug. 1962). (In German)

In order to investigate the question proposed by Rajewsky and Wolf on the effect of the DNA structure on the radiation chemical modification of bases, the DNA spiral was dissolved in distilled water and irradiated with x rays. An increase of the radiation sensitivity of the bases, especially at the beginning of the irradiation, was observed with respect to the value detected in the irradiation of the monomer. In the irradiation of DNA dissolved in 0.1 and 1 $\underline{N}$ NaCl, on the other hand, the bases are protected against the effect of the radical formed in the water so long as they are bound within the intact spiral. This structure-limited protection effect does not exist against the direct radioeffect of UV light. This result is of radiobiological importance since the optimum of the radioeffect on the mitosis development lies in the early prophase according to Carlson and Gray, and also in a phase in which the DNA spiral (before doubling) is completely decomposed. (tr-auth)

**4619** IRRADIATION GRAFTING OF ACRYLONITRILE ON VINYL CHLORIDE-VINYLIDENE CHLORIDE COPOLYMERS. Robert Roy Smith, Dennis Charles MacMillan Mann, and Enid Bevis (to B. X. Plastics Ltd.). U. S. Patent 3,066,085. "Priority date Sept. 4, 1957 Great Britain."

A copolymer of vinyl chloride and vinylidene chloride is subjected to ionizing radiation while in contact with acrylonitrile monomer. Essentially thermoplastic or cross-linked structures are obtained. Significant graft-polymerization can be effected with doses of 20,000 rep or less. (R.J.S.)

**4620** METHOD OF CONVERTING A SOLUTION OF A RADIOACTIVE SALT INTO COMPACT SOLID FORM. Benjamin Frank Warner, James Henry Tonkin, and David Shaw (to United Kingdom Atomic Energy Authority). U. S. Patent 3,066,728. "Priority date Nov. 20, 1956 Great Britain."

A method is described for converting a highly radioactive salt solution into a compact solid form. The solution is evaporated to dryness at one temperature in a funnel sealed by a fusible plug, blocking entry to a capsule, and subsequently heated at a higher temperature to fuse the plug and the salt so that the salt will enter the capsule. (R.J.S.)

## Raw Materials and Feed Materials

**4621** (EURAEC-346) SINTERING OF $UO_2$. Special Report No. 3. CONTINUOUS PREPARATION IN LABORATORY OF URANIUM DIOXIDE POWDERS SUITABLE FOR SINTERING IN HYDROGEN AT 1650°C. P. Chenebault and R. Delmas (France. Commissariat à l'Energie Atomique, Paris). Jan. 1962. Work Performed under United States-Euratom Joint Research and Development Program. 25p. A translation of DM-1156.

Commercial uranium trioxide, prepared by continuous calcination of ammonium diuranate, is reduced to uranium dioxide in a continuous rotary furnace with an excess of cracked ammonia. The uranium dioxide powder obtained, of about three $m^2/g$ specific surface, can be sintered in hydrogen at 1650°C at a density of about 96% of the theoretical density. (R.J.S.)

**4622** EFFECTS OF ALKALI CARBONATE METAL ADMIXTURES ON THE RATE OF $UO_3$ REDUCTION. V. M. Zhukovskii and V. G. Vlasov (Kurov Urals Polytechnic Inst., USSR). Zh. Prikl. Khim., 35: 2131-4(Oct. 1962). (In Russian)

Effects of alkali carbonate admixtures ($Li_2CO_3$, $Na_2CO_3$, and $K_2CO_3$) on the rate of $UO_3$ reduction by decomposed ammonia ($3H_2 + N_2$) were studied. It was found that the admixtures slow the process. The slowing down effect increases from $Li_2CO_3$ to $Na_2CO_3$ to $K_2CO_3$. Further additions (from 0.2 to 20 mol %) enhance the effects. (R.V.J.)

**4623** IMPROVEMENTS IN METHODS FOR THE ALKALINE TREATMENT OF URANIUM ORES BY MEANS OF ION EXCHANGE RESINS. Pierre Mouret, Bernard Parly, and Paul Pottier (to Commissariat à l'Energie Atomique). British Patent 910,025. Nov. 7, 1962.

After crushing, uranium ore is subjected to an alkaline leach. An ion exchange resin is employed to adsorb uranium from the resulting solution. Elution of the saturated base follows, the uranium being precipitated from the eluate by treatment with a base. (R.J.S.)

**4624** PROCESS FOR THE PRODUCTION OF URANIUM TETRAFLUORIDE FROM URANIUM RAW MATERIAL. Chuko Ito, Takeo Okuda, and Naohiko Hamabe (to Mitsubishi Kinzoku Kogyo Kabushiki Kaisha). U. S. Patent 3,065,045. Nov. 20, 1962.

This process consists of the following steps: dissolving and leaching uranium raw material with sulfuric acid, adding a tetravalent uranium solution obtained by electrolytic reduction to the leach, subjecting the leach exuded by sulfuric acid to an extraction with an organic solvent to refine and concentrate uranium, converting the extract to a tetravalent uranous solution by electrolytic reduction, and reacting hydrogen fluoride with the uranous solution to produce uranium tetrafluoride. (R.J.S.)

## Separation Processes

*Refer also to abstracts 4887 and 5610.*

**4625** (HW-SA-2767) RECENT SOLVENT EXTRACTION STUDIES AT HANFORD LABORATORIES. R. E. Burns (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Oct. 5, 1962]. Contract AT (45-1)-1350. 29p.

Solvent extraction of Cr, Sr, Np, and rare earths from Purex waste and separation of Cs from stored waste supernatant liquids are discussed. (R.J.S.)

**4626** (HW-SA-2797) AMINES AS EXTRACTANTS—STUDIES OF THE ORGANIC PHASE. W. E. Keder and A. S. Wilson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Oct. 15, 1962]. Contract AT(45-1)-1350. 37p.

The extraction of acids and metals by solutions of long-chain alkyl amines is described as a process of neutralization of the amine in the organic phase by acid extracted from the aqueous phase and of exchange of anions between the phases. Affinities of tri-n-octylamine for various mineral acids and the extraction of stoichiometric excesses of these acids by TOA solutions are discussed. Analyses of water content of the amine solutions and proton magnetic resonance measurements were combined with those of excess acid to describe the amine solutions in equilibrium with concentrated acids. Amine concentration dependence of extraction, capacities of amine solutions for metals, and absorption spectra were used to establish the identity of metal species which extract into alkyl ammonium solutions. The results obtained for extraction of various metals from several acid solutions are discussed, with emphasis on tetra- and hexavalent actinides. (auth)

**4627** (HW-SA-2810) MATERIALS OF CONSTRUCTION IN NUCLEAR FUELS SEPARATIONS FACILITIES. William L. Walker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Oct. 26, 1962]. Contract AT(45-1)-1350. 17p.

It is noted that the unique features of the materials to be processed in nuclear facilities and the nature of most separation processes impose stringent requirements on process plant construction materials. Considerations related to material selection are discussed. It is concluded that in processing nuclear fuels, vessel integrity is of primary importance, and relatively large expenditures for materials quality control are justified until such time as acceptable materials of construction are commercially available on a routine basis. (J.R.D.)

**4628** (NAA-SR-7136) LOW DECONTAMINATION REPROCESSING STUDIES ON IRRADIATED URANIUM DIOXIDE REACTOR FUEL. J. Guon, J. E. Bodine, R. J. Sullivan, and F. W. Gandolfo (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 30, 1962. Contract AT(11-1)-Gen-8. 38p.

As a part of the demonstration of the reprocessing-refabricating phase for a uranium dioxide fuel cycle, 100-g quantities of oxide, irradiated to burnups as great as 15,000 Mwd/MTU, were processed. Fuel was remotely declad by oxidation, and the resulting powder alternately oxidized in air and reduced in hydrogen. A final $UO_2$ powder was obtained which had properties amenable to refabrication by cold pressing and sintering. No significant fission product or plutonium decontamination occurred. Processing losses were less than 0.1%. No equipment or processing problems were encountered which would prevent further scaleup of the process. (auth)

**4629** THE QUANTITATIVE SEPARATION OF PLUTONIUM FROM VARIOUS IONS BY ANION EXCHANGE. Ivan K. Kressin and Glenn R. Waterbury (Los Alamos Scientific Lab., N. Mex.). Anal. Chem., 34: 1598-1601 (Nov. 1962). (LADC-5352)

The anion exchange resin separation of plutonium was investigated as a possible technique for the rapid quantitative separation of plutonium from various metal ions. A slurry-column technique provided satisfactory separation of plutonium from quite a large number of metal ions. In this method, plutonium(IV) was adsorbed from 7.2M nitric acid onto Dowex 1 X2 resin, and the other metal ions washed from the column with nitric acid of the same strength. Then the plutonium was eluted with a 0.36M hydrochloric-0.01M hydrofluoric acid mixture. The separation was rapid and permitted an average recovery of 100.00% of the plutonium with a standard deviation of 0.048% for known solutions. Of the 46 diverse ions investigated, only silicon reduced the recovery of the plutonium below 99.9%. Applications of this separation to various methods of analysis of plutonium-containing materials are discussed. (auth)

**4630** DRYING AND CALCINING OF RAFFINATE FROM URANYL NITRATE EXTRACTION. D. S. Arnold, J. S. Cavendish, H. C. Heareth, and W. C. Manser (National Lead Co. of Ohio, Cincinnati). Chem. Eng. Prog., Symp. Ser., 58: 1-7(1962). (M-6671)

The results of process development work on raffinates with drying and calcining procedures are presented. Included are discussions of the problems encountered, process studies completed, and chemical engineering data obtained both in pilot plant and plant start-up tests on the dryer and calciner installations. (auth)

**4631** A STUDY OF THE SOLVENT EXTRACTION OF THORIUM WITH THIOCYANATE. Ying-Mao Chen, Peng-Joung Sun, and Fa-Chun Chou (National Taiwan Univ., China). J. Chinese Chem. Soc. (Taiwan), 8: 56-62(Mar. 1, 1961). (In English)

A study was made of the effects of organic solvents, acidity, and the concentration of thiocyanate on the effectiveness of the solvent extraction of thorium. It was found that both cyclohexanol and a mixture of isoamyl alcohol and ethyl acetate were effective solvents, the most favorable acidity for the extraction of thorium was at pH 4, and the extractability of thorium increased with increasing thiocyanate concentration, reaching a maximum value when thiocyanate concentration was 3N, and then decreasing slightly. (auth)

**4632** THE DEVELOPMENT AND APPLICATION OF A PROCESS FOR THE RECOVERY OF OVER 100g OF PROTACTINUM-231 FROM A URANIUM REFINERY WASTE MATERIAL. D. A. Collins, J. J. Hillary, J. S.

Nairn, and G. M. Phillips (United Kingdom Atomic Energy Authority, Windscale and Calder Works, Sellafield, Seascale, Cumb., Eng.). J. Inorg. & Nucl. Chem., 24: 441-59 (Apr. 1962). (In English)

The development is described for a process for the recovery of protactinium-231 and uranium from a residue known as ethereal sludge that was produced during uranium refining at the U.K.A.E.A. Springfields Works. The process is suitable for operation on a large scale and involves the following stages: 1. Leaching protactinium and uranium from the sludge with cold 4N-$HNO_3$ in the presence of fluoride. 2. Recovering uranium by extraction into 20 per cent TBP–kerosene. 3. Adding aluminum chloride to the aqueous raffinate and separating a precipitate that carries protactinium. 4 Treating the precipitate with cold NaOH solution and then dissolving it in concentrated hydrochloric acid. 5. Recovering protactinium by extraction into diisobutylketone. In laboratory operations the process proved capable of recovering 98 to 99 per cent of the uranium and 65 to 70 per cent of the protactinium originally present in the ethereal sludge. The above process was successfully applied to the recovery of over 100 g of protactinium and of nearly 12 tons of uranium with an efficiency of 63 per cent for protactinium and 99.4 per cent for uranium. (auth)

**4633** SEPARATION OF HAFNIUM FROM ZIRCONIUM AND THEIR DETERMINATION: SEPARATION BY ANION-EXCHANGE. Lawrence A. Machlan and John L. Hague. J. Res. Natl. Bur. Std., A, 66: 517-20(Nov.-Dec. 1962).

A procedure is described for the separation of Hf from Zr and for their individual determination. The sample is dissolved in sulfuric and hydrofluoric acids and the hydrofluoric acid removed by fuming. After dilution with water, the solution is transferred to a column containing a strong quaternary amine anion-exchange resin (Dowex-1). The Hf is eluted with diluted (3.5% by vol.) sulfuric acid solution. Zr is removed by elution with 10% by vol. sulfuric acid solution. The elements are precipitated with cupferron, ignited, and weighed as the oxides. For samples containing from 20 to 80% Zr, a second separation of the Hf fraction using the column is necessary. (auth)

**4634** THE MECHANISM OF EXTRACTION OF TRIBUTYL PHOSPHATE-n-HEXANE SOLVENTS. PART I. WATER EXTRACTION. Donald R. Olander (Univ. of California, Berkeley) and Manson Benedict. Nucl. Sci. Eng., 14: 287-94(Nov. 1962).

The mechanism of water extraction into tributyl phosphate-n-hexane solvents has been investigated in a stirred-vessel transfer cell. The effects of stirrer speed, temperature, and the comparison of the TBP-hexane results to those for water transfer into ordinary nonreacting organic solvents strongly suggest that the process is one of simple mass transfer. No effect of complexing, which might have formed the species $H_2O \cdot TBP$, was found. The kinetic data (in the form of a single-phase mass transfer coefficient) were all correlated to within ±10% by the relation $(k/v)Sc^{0.44} = 0.046\ (\omega/v)^{0.67}$, where k is the individual mass transfer coefficient, v the kinematic viscosity of the solvent phase, $\omega$ the stirrer speed, and Sc the Schmidt number, v/D. (auth)

**4635** AMALGAM EXCHANGE BETWEEN Li–K, Li–Na, AND Li–Ca. B. P. Konstantinov and I. A. Alimova. Zh. Prikl. Khim., 35: 2266-71(Oct. 1962). (In Russian)

Coefficients for Li–K and Li–Na separation by an exchange between amalgam and hydroxide solution are 1 to $2 \times 10^5$, and for Li–Ca exchange between amalgam and chloride $\alpha = 2800 \pm 500$. The density of the exchange current is high and in some cases reach dozens of kiloamperes per square meter. The density increases linearily with the rate of mixing. The results confirm the efficiency of amalgam separation for alkali and alkali earth elements. (R.V.J.)

**4636** IMPROVEMENTS IN OR RELATING TO METHODS OF RECOVERING PLUTONIUM. William Douglas Jamrack and Gwilym Morgan Phillips (to United Kingdom Atomic Energy Authority). British Patent 910,443. Nov. 14, 1962.

A method is described for recovering plutonium in solutions of high purity and concentration from dilute impure solutions. It is particularly applicable to plutonium solutions from which major amounts of associated uranium and fission products have already been removed by solvent extraction from nitric acid solutions of neutron-irradiated uranium. (R.J.S.)

**4637** METHOD FOR SEPARATING THORIUM AND YTTRIUM VALUES. William N. Vanderkooi (to Dow Chemical Co.). U. S. Patent 3,067,004. "Application date Oct. 5, 1959."

A method is presented for the recovery of thorium and yttrium values from dilute aqueous acidic solutions. The aqueous acidic salt solution containing dissolved thorium and yttrium values is brought into contact with a bed of a chelating resin, which shows a preferential sorption for the thorium values. The chelating resin can be easily regenerated for reuse. (R.J.S.)

# ENGINEERING AND EQUIPMENT

## General and Miscellaneous

*Refer also to abstracts 4444, 4445, 4446, 4447, 4448, 4755, 5627, and 5629.*

**4638** (AD-274164) HIGH TEMPERATURE THERMOELECTRIC GENERATOR. Quarterly Progress Report No. 2, January 1, 1962—March 30, 1962. C. M. Henderson and R. G. Ault (Monsanto Research Corp. Dayton Labs., Ohio). Contract AF33(657)-7387. 50p.

The development continued of a 5-watt laboratory thermoelectric generator capable of operating at a hot junction temperature of 1200°C in a vacuum of 0.00001 mm Hg. Fourteen candidate junction materials were screened for use with MCC 50 in the production of thermocouple modules. Of these, C, Mo, and W are being considered for the end product generator. Three methods for fabricating thermocouple modules with MCC 50 were studied and a hot-press/braze method selected for use in the making of modules for the end product. In sublimation rate loss tests conducted for 500 hr at 1200°C at 0.00001 to 0.000001 mm Hg, MCC 50 thermoelectric material lost only 0.53% weight. The rate of sublimation loss appears to decrease with time. Measurements of electrical properties of modules, before and after 100 hr tests at 1200°C, indicate the end product generator can be operated well beyond 1000 hrs, the design goal. Merit factors (Z) of MCC 50, based on extrapolations of thermal conductivity measurements from 1000°C, range from 0.0006 to 0.0011 per degree at 1200 to 1500°C. A 4-module prototype generator unit was constructed and is being tested at 1200°C in a vacuum. (auth)

**4639** (ORNL-3294) AN AERODYNAMIC-THERMODYNAMIC STUDY OF CENTRIFUGAL COMPRESSORS. G. T. Colwell (Oak Ridge National Lab., Tenn.). Dec. 18, 1962. Contract W-7405-eng-26. 88p.

A procedure is presented for the aerodynamic and thermodynamic design of centrifugal compressors. Design equations are derived from basic laws of thermodynamics and fluid flow where possible. The experimental data and much of the mathematical treatment comes from the extensive literature on centrifugal compressors. An attempt has been made to assemble the bits of information which were available into a logical design method. The available information has been supplemented with mathematical developments and explanations which seemed necessary to complete the general view of centrifugal compressor design. Of particular interest is the derivation, using the work of Stanitz and Ellis (NACA Report 954) as a starting point, of equations which provide for estimating the velocity distribution on the leading edge of an impeller vane. Also included is an example of an aerodynamic-thermodynamic design of an impeller and a volute-conical diffuser combination. All the necessary steps are demonstrated, beginning with a set of basic compressor requirements and resulting in a layout of the impeller and casing. (auth)

**4640** (TID-15465) A NEW FACTOR INFLUENCING ELECTRICAL BREAKDOWN IN VACUUM. E. E. Donaldson and M. Rabinowitz (Washington State Univ., Pullman). Mar. 22, 1962. Contract AT(45-1)-1548. 6p.

It was recently found that particles of contamination reside on surfaces inside glass vacuum systems as a result of thermal decomposition of glass. These particles contain at least Na, K, and B as well as traces of Al and Si and they were important in many clean surface experiments. An investigation showed that the particles have a strong influence on the vacuum breakdown voltage for nearly plane electrodes and that they afford evidence in support of a clump mechanism of breakdown at low voltages. (auth)

**4641** (TID-17378) AN INVESTIGATION OF FACTORS IMPORTANT IN THE DESIGN OF A THERMAL PRECIPITATOR FOR USE AT HIGH ALTITUDE. Final Report, May 15, 1959 to May 15, 1962. Thomas W. Wilson and Clyde Orr, Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(40-1)-2568. 104p.

The particle collecting capability of thermal precipitators has been investigated. The objectives of the study have included the effectiveness of thermal precipitation and its dependence upon operating pressure, particle size, precipitator plate separation distance, and aerosol throughput velocity. The actual performance of the experimental precipitator has been of primary concern. Data have been accumulated to provide a practical guide for the design of a thermal precipitator for the high altitude sampling of atmospheric particulate material. Results have been compared with theory and found to be generally consistent. (R.J.S.)

**4642** (UCRL-Trans-876(L)) EXPANSION OF A CIRCULAR CYLINDRICAL TUBE SUBJECTED TO DYNAMIC LOADS. I. Z. Stepanenko. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore) from Prikl. Mekhan., 3: 225-8(1957). 6p.

Results of an investigation are presented concerning an infinitely long tube of ideal plastic material, on whose inner surface a uniformly distributed impulse is acting. The motion of the inner tubular surface is determined along with the time expansion of the tube. (J.R.D.)

**4643** ELECTROMAGNETIC PUMPS FOR LIQUID METALS. D. S. Armstrong (AEI Research Lab., Rugby, Eng.). AEI (Assoc. Elec. Ind.) Eng., 2: No. 6, 289-95 (Nov.-Dec. 1962).

The mode of operation and performance of electromagnetic pumps in general is described along with various alternative designs and their characteristics. Discussion is given on linear, helical, and flat induction pumps. The ALIP is capable of pumping metals at 600°C with an efficiency of 20%. A FLIP without sidebars and with a refractory channel can handle metals up to at least 1500°C, although efficiency values are probably less than 2% at that temperature. It is concluded that the electromagnetic pump provides a reliable means of moving liquid metals. (P.C.H.)

**4644** TAPE TRANSPORT TRANSPORTS SAMPLE AS WELL. Joseph J. Ronchetto, Jr., (Univ. of California, Livermore). Control Eng., 9: 139(1962). (UCRL-6607)

A closed tape loop system was developed for moving a light-weight (50-mg) U foil into a high neutron flux, irradiating it for a preset time, removing it from the flux, permitting it to decay for a preset time, recording its beta spectrum on a pulse height analyzer for another preset time, and repeating the cycle. The timing is accomplished with time delay relays and gated scalers. (D.L.C.)

**4645** ELEMENTS OF ENERGY STORAGE CAPACITOR BANKS. E. L. Kemp (Los Alamos Scientific Lab., N. Mex.). Elec. Eng., 81: 1-5(Sept. 1962). (LADC-5353; TID-14530)

The characteristics of the components of a capacitor bank are discussed: capacitor, switch, transmission system, and charging system. Safety precautions necessary in the use of banks are outlined. (D.L.C.)

**4646** FAST HIGH-SENSITIVITY SILICON PHOTODIODES. R. L. Williams (RCA Victor Research Labs., Montreal). J. Cpt. Soc. Am., 52: 1237-44(Nov. 1962).

A photodiode made on high-resistivity silicon (greater than 100 Ω-cm) is characterized by a relatively wide junction-depletion layer. As a consequence, for most of the spectral response region the optical generation of charge carriers occurs within the depletion layer and the separation and collection of charge is primarily controlled by electric field rather than by diffusion. Short collection times thus obtained are estimated to be in the range from 10 to 100 nsec and have been shown to be 200 nsec or less. By choice of sufficiently high resistivity and moderate reverse biases the device capacitance can be kept smaller than circuit stray capacitances. Low values of saturation current have been obtained resulting in high diode sensitivities. Best measured noise-equivalent-power values of $2 \times 10^{-13}$ w at 0.9 μ are about a factor 2 short of theoretical values. (auth)

**4647** SUPERCONDUCTIVITY. 2. HEAT-DRAINED HARDWARE. Randall F. Barron (Ohio State Univ., Columbus). Machine Design, 34: No. 5, 24-8(Mar. 1, 1962).

Promising applications for superconductivity are briefly surveyed. Many of the proposed applications are not practical and many that are technically feasible still have economic barriers to hurdle. Topics discussed include floating rotors, field-lubricated bearings, no-loss motors, many-purpose switches, thin-film magnets, d-c transformers, and superconducting tunnel diodes. (W.D.M.)

**4648** FINNED TUBES FOR NUCLEAR WORK. A VISIT TO TUBE PRODUCTS LIMITED. Nucl. Eng., 7: 492-3(Dec. 1962).

The production of finned tube is discussed briefly in terms of operations, inspection, and testing. (W.D.M.)

**4649** SEMIAUTOMATIC APPARATUS FOR THE CONTROL OF RADIUM PREPARATIONS. M. Chiozzotto, G. Di Nunzio, and A. Grisanti (Comitato Nazionale Energia Nucleare, Rome). Rend. Ist. Super. Sanita, 24: 858-70(1961). (RT/PROT(62)3) (In Italian)

An apparatus, planned and constructed in the Laboratory of Physics of the Istituto Superiore di Sanità is described, which provides for the examination of radium tubes and needles used for therapeutic purposes and their selection and distribution in different containers. The apparatus acts semiautomatically, allows the work to be done at a greatly increased speed, and at the same time guarantees the protection of the operator. (auth)

**4650** FAST CLOSING VACUUM VALVE OF LARGE APERTURE. V. Round (Ecole Normale Superieure, Orsay, France). Rev. Sci. Instr., 33: 758-9(July 1962).

A guillotine valve is described that is designed to seal off a vacuum system within 12 msec of the beginning of vacuum deterioration. Deterioration of the vacuum is indicated within a few μsec by a vacuum gage, the remaining time is taken up in the motion of the guillotine slide, which moves 50 mm. The proximate cause of the vacuum loss is, in the case for which the valve is designed, the rupture of a thin Al foil window that separates the vacuum system from a region at atmospheric pressure. (T.F.H.)

**4651** TRANSISTORS FOR AVALANCHE-MODE OPERATION. Harold W. Miller and Quentin A. Kerns (Univ. of California, Berkeley). Rev. Sci. Instr., 33: 877-8(Aug. 1962). (UCRL-10131(Rev.))

Selected Motorola transistors of the MM-486, MM-487, and MM-488 type are useful for avalanche-mode operation. A test circuit is described for selecting avalanche units. Generally, 10 to 30% of the transistors will avalanche, although the low-beta type (MM-486) appears to give the best yield. The time delay and temperature effects are described briefly. (D.L.C.)

**4652** IMPROVEMENTS IN OR RELATING TO RETARDING DEVICES. Peter Roy Smith (to United Kingdom Atomic Energy Authority). British Patent 909,340. Oct. 31, 1962.

A device is described for effecting controlled deceleration of drums after a pre-determined degree of rotation. (R.J.S.)

**4653** IMPROVEMENTS IN OR RELATING TO COUPLING DEVICES. Herbert Chilvers Knights (to United Kingdom Atomic Energy Authority). British Patent 909,646. Oct. 31, 1962.

A coupling device has been designed which remains coupled under tensile or compressive load and is simple to uncouple remotely. The device has an application in the coupling of a string of reactor fuel elements to a neutron shield plug. (R.J.S.)

**4654** IMPROVEMENTS IN FITTINGS FOR CLOSING HANDHOLES OR THE LIKE OPENINGS IN PRESSURE VESSELS. (to Babcock and Wilcox Co.). British Patent 909,775. Nov. 7, 1962.

The fitting includes a head adapted to press a gasket on to a seat at the inner side of the opening, a binder member adapted to seat against the pressure vessel at the outer side of the opening, a stem projecting from the head through the binder member, a nut on the stem to draw the head against the gasket, and a device to indicate sufficient tightening of the nut. (R.J.S.)

**4655** IMPROVEMENTS IN OR RELATING TO ELECTROLYTIC CELLS. Thomas Mealor Pyke and Leslie Proffitt Kennett (to United Kingdom Atomic Energy Authority). British Patent 910,351. Nov. 14, 1962.

Blades are described for removing beryllium deposits from the base of a beryllium – sodium chloride electrolysis cell. (R.J.S.)

**4656** IMPROVEMENTS IN OR RELATING TO ELECTROLYTIC CELLS. Thomas Mealor Pyke and Leslie Proffitt Kennett (to United Kingdom Atomic Energy Authority). British Patent 910,352. Nov. 14, 1962.

A method is described for scraping of dendritic metallic beryllium deposits from the cathode of an electrolytic cell after electrolysis of a beryllium – sodium chloride eutectic. (R.J.S.)

**4657** DISPLAY DEVICE FOR USE IN INSTALLATIONS FOR CYCLICALLY CHECKING BY MEANS OF A LIMITED NUMBER OF APPARATUS, THE VALVES [VALUES] OF A MAGNITUDE AT A MULTIPLICITY OF POINTS. Roland Cochinal, Jean Goupil, and Jean Megy (to Commissariat à l'Energie Atomique). British Patent 910,445. Nov. 14, 1962.

A cyclical switch device is used to ensure successive and repeated determinations of a magnitude for a system of points. Details of the design are described. (R.J.S.)

**4658** IMPROVEMENTS IN OR RELATING TO CONTROL VALVES AND TO PLANT INCORPORATING CONTROL VALVES. Stefan George Bauer and Norman Battle (to Rolls-Royce Ltd.). British Patent 910,515. Nov. 14, 1962.

A control valve was designed that consists of a central pressure space with connections to a pair of end spaces and a control member. Such a valve may be employed to control the pressure in the central space to a selected valve by connecting the end spaces to a high pressure supply and a low pressure region. (R.J.S.)

**4659** REMOTE CONTROL MANIPULATOR. Charles E. Saunders, Jr. (to American Machine and Foundry Co.). U. S. Patent 3,065,863. "Application date Jan. 13, 1961."

A development is described for a remote-control manipulator that allows the slave arm to extend while the master arm is maintained in operating position at any level of extension. This arrangement permits the manipulator to operate at any axial level of the slave arm relative to the master arm so that extension of the master arm in normal operation movements causes a corresponding extension of the slave end. (R.J.S.)

## Heat Transfer and Fluid Flow

*Refer also to abstracts 5578 and 5628.*

**4660** (CUA-NE-25) SIMULATED NUCLEAR REACTOR VIBRATIONAL HEAT TRANSFER. Quarterly Progress Report, May 1, 1962–July 31, 1962. (Catholic Univ. of America, Washington, D. C.). Contract AT(30-1)-2655. 4p.

A program of pool heating at atmospheric and at vibrational frequencies from about 10 cps to approximately 1 mcps was established as a necessary prerequisite to a pressurized, forced convection heat transfer testing program. The heater was installed in the test tank. It was subjected to heating tests and did not leak. Tests were conducted in the acoustic vibration tank at frequencies ranging up to 100 kcps. No improvement in heat transfer was detected. Calibration tests were conducted to determine the heater acceleration and displacement as a function of the motion of the shaker table. (M.C.G.)

**4661** (ORNL-TM-402) MAGNETOHYDRODYNAMIC STABILITY OF VORTEX FLOW—A NONDISSIPATIVE, INCOMPRESSIBLE ANALYSIS. Tien S. Chang (Oak Ridge National Lab., Tenn.). Oct. 23, 1962. Contract [W-7405-eng-26]. 36p.

A preliminary nondissipative, incompressible magnetohydrodynamic stability analysis against turbulent breakdown of vortex flow with possible application to an ionized gas-phase fission reactor is presented. It was found that a vortex flow enclosed within two concentric cylindrical walls can be stabilized against possible turbulent breakdown by means of an axially applied magnetic field. The magnitude of this magnetic field varies with the density of the fluid, the peripheral velocity of the vortex, and the radii of the cross sections of the concentric cylindrical walls. For an actual vortex heat exchanger, the vortex has a small but finite, radial flow throughout the flow region. Analysis showed that there exists a possible stationary state of a combination vortex-sink flow with a (1/r)-characteristic. This means that, in principle, a separate analysis should be made to consider the stability of such a stationary flow. However, since the finite radial flow velocity in an actual vortex heat exchanger is expected to be small compared with the transverse velocity, it might be expected that the magnitude of the axially applied magnetic field for partial stabilization of such vortex-sink flow is of the same order of magnitude as that obtained for confined pure vortex flow. Forced boundary-layer oscillations and instability due to flow against concave walls were not considered in this analysis, nor was the effect of the axial flow in the inner core. These effects not only introduce instability in the boundary layer and the inner core but also control the effective radii of the inner and outer boundaries containing the vortex-sink flow. (auth)

**4662** (AEC-tr-5538) THE EFFECT OF CHANNEL GEOMETRY ON THE CRITICAL HEAT LOADS IN THE FORCED FLOW OF WATER. B. A. Zenkevich, O. V. Remizov, and V. I. Subbotin. Translated for Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh from Teploenerg., 9: No. 7, 81-3(1962). 7p.

Results of experiments on burnout in triangular and rectangular channels are presented. The curve for the heat flux at the inside surfaces can be characterized, to a first approximation, by the ratios of heat fluxes $q^{w}_{loc}/q_{cr}$ and $q^{c}_{loc}/q_{cr}$, the values of which are 0.973 and 3.620, respectively for the triangular channel, and 0.877 and 1.757 for the rectangular channel. (J.R.D.)

**4663** (AEC-tr-5539) EXPERIMENTAL INVESTIGATION OF THE CONDITIONS OF DETERIORATION OF HEAT TRANSFER DURING BOILING IN TUBES. A. S. Kon'kov and V. V. Modnikova. Translated for Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh from Teploenerg., 9: No. 8, 77-81(1962). 11p.

Results of an investigation of conditions associated with deterioration of heat transfer during the flow of steam-water mixtures in vertical tubes over a wide parameter variation range are presented. The experiments were conducted at pressures of 20, 50, 100, 150, and 200 atm. abs. The mass flow rate varied between 100 and 13,200 $kg/m^2/sec$ and the heat load between $85 \times 10^3$ and $3.34 \times 10^6$ $kcal/m^2/hr$. (J.R.D.)

**4664** THE THEORY OF THIN FLANGES IN MAGNETOHYDRODYNAMICS. Lazare Dragos (Université, Bucharest). Compt. rend., 255: 1251-3(Aug. 20, 1962). (In French)

The motion of a conducting fluid, of arbitrary conductivity, in the presence of a thin profile is considered. The exact solution for any $R_M$ is given. (J.S.R.)

**4665** EXPERIMENTAL STUDY OF TEMPERATURE DISTRIBUTION IN LAMINAR TUBE FLOW OF A FLUID WITH INTERNAL HEAT GENERATION. Robert M. Inman (Univ. of California, Los Angeles). Intern. J. Heat Mass Transfer, 5: 1053-8(Nov. 1962).

An experimental investigation of laminar fluid flow in a circular tube with internal heat generation was conducted. Wall-temperature measurements were made for a uniform internal heat source in an insulated tube, and excellent agreement was demonstrated between the experimental results and a theoretical analysis by others. (auth)

**4666** CONDUCTION WITH TIME-DEPENDENT HEAT SOURCES AND BOUNDARY CONDITIONS (A MODIFIED SEPARATION-OF-VARIABLES TECHNIQUE). I. U. Ojalvo (Republic Aviation Corp., Farmingdale, N. Y.). Intern. J. Heat Mass Transfer, 5: 1105-9(Nov. 1962).

A procedure for extending the separation-of-variables technique to heat-conduction problems with time-dependent heat sources and boundary conditions is presented. It is shown how a modification of the separation method, similar to one made when seeking vibration solutions and applicable to many linear partial-differential equations, transforms problems of this general class into a set of transient and steady-state sub-problems for which solution methods are well established. Results take the form of quasi-static expressions superimposed upon a product series involving characteristic functions of the corresponding uniformly excited cases. The method is thus suitable for extending existing solutions to time-dependent heat-source and end conditions, as well as offering an alternative and occasionally more convenient approach from better-known integral methods. (auth)

**4667** LARGE-SCALE MODEL INVESTIGATION OF THE AXIAL HEAT TRANSFER VARIATION ALONG THE

POLYZONAL SPIRAL SURFACE OF FUEL ELEMENT CANS USED IN GAS-COOLED NUCLEAR POWER REACTOR SYSTEMS. S. B. H. C. Neal and J. A. Hitchcock (Central Electricity Research Labs., Leatherhead, Eng.). J. Brit. Nucl. Energy Soc., 1: 307-17(Oct. 1962).

The heat transfer properties vary considerably along the length of polyzonal spiral fuel elements. These variations result in hot spots, which limit reactor output. A large-scale model can, constructed to allow a detailed survey to be made of fluid flow and heat transfer patterns, is described together with the experimental techniques employed. The experimental results enable an analysis to be made of the factors contributing towards the pattern of axial heat transfer variation, and allow an approach to be adopted towards its elimination or reduction. (auth)

**4668** HEAT TRANSFER IN INTENSIVELY OUTGASSED POWDERS. R. C. Little, F. G. Carpenter, and V. R. Deitz (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 37: 1896-8(Oct. 15, 1962).

An apparent thermal conductivity that was somewhat lower than previous measurements was found for outgassed graphite in the presence of small amounts of argon. The value for the effective conductivity was found to be of the order of $2 \times 10^{-6}$ cal/cm sec deg. The apparent conductivity increased sharply when the adsorbing gas was introduced to the evacuated powder in sufficient quantities so that at equilibrium adsorption the surface coverage was about 5%. Changes in slope suggest a change in the mode of heat transfer. Discussion is given on the possible mechanism for the conductivity. (P.C.H.)

**4669** EFFECT OF NATURAL CONVECTION ON STABILITY OF FLOW IN A VERTICAL PIPE. George F. Scheele and Thomas J. Hanratty (Univ. of Illinois, Urbana). J. Fluid Mech., 14: 244-56(Oct. 1962).

If water is heated or cooled while flowing through a vertical pipe with a laminar motion, the velocity profile will differ from the parabolic shape for isothermal flow due to density variations in the fluid. If a constant heat flux is used at the wall and if the changes in temperature affect only the density appearing in the gravity term of the equations of motion, a condition is attained far downstream in the heat-transfer section such that there is no further change in the velocity profile. The shape of this fully developed velocity profile depends on the ratio of the heat flux to the flow rate. The stability of flow in an electrically heated pipe 762 diameters long was studied by detecting temperature fluctuations in the effluent. By use of a carefully designed entry and a long isothermal section prior to the heat exchange section, inlet disturbances were eliminated and transition to an unsteady flow resulted from a natural instability of the distorted profiles. It was found that the stability depends primarily on the shape of the velocity profile and only secondarily on the value of the Reynolds number, if at all. For upflow heating the flow first becomes unstable when the velocity profiles develop points of inflexion. Transition to an unsteady flow involves the gradual growth of small disturbances and therefore it is quite possible to have unstable flows without observing transition because the pipe is not long enough for the disturbances to attain a measurable amplitude. For downflow heating the flow instability is associated with separation at the wall. Transition to an unsteady flow is sudden and therefore transition occurs shortly after an unstable flow occurs. It is suggested that a change from a steady symmetrical to a steady unsymmetrical flow occurs in downflow when the profile develops points of inflexion. (auth)

**4670** THERMAL EFFICIENCY OF COATED FINS. J. A. Plamondon (California Inst. of Tech., Pasadena). J. Heat Transfer, 84: 279-82(Nov. 1962).

The surfaces of a fin from which heat is rejected solely by radiation may have to be coated to obtain high values of thermal emissivity. In order to determine the influence of the conductive resistance of a coating on the thermal performance of a fin, an analysis was undertaken. Two equations are derived to describe the heat-transfer characteristics of a coated fin: One, a differential equation for the temperature profile on the radiating surfaces of the coating; and two, an equation for the relative thermal performance of the fin in terms of fin efficiency. The equations are solved numerically, and the fin efficiencies are plotted as a function of two dimensionless parameters which appear in the differential equation. These efficiencies are compared with those for fins in which the conductive resistance of the coating is ignored. (auth)

**4671** HEAT TRANSFER BY COMBINED FORCED CONVECTION AND THERMAL RADIATION IN A HEATED TUBE. M. Perlmutter and R. Siegel (National Aeronautics and Space Administration, Cleveland). J. Heat Transfer, 84: 301-11(Nov. 1962).

An analysis is made to study the heat exchange by combined forced convection and thermal radiation in a tube when there is a specified heat flux imposed at the tube wall. The gas flowing in the tube is assumed transparent to radiation, so that the radiation which is included takes place between the elements of the internal tube surface and between this tube surface and the environment at each end of the tube. The inside surface of the tube is a black emitter and the outside is assumed perfectly insulated. The heat-transfer coefficient for convection alone from the tube wall to the gas is assumed constant. The energy equation governing the heat exchange is solved by two methods which provide results that are in good agreement with each other. Numerical examples of the wall and gas-temperature variations along the tube show the influence of the system parameters such as inlet gas temperature, tube length, and convective heat-transfer coefficient. A simple method is outlined, which can be used under some conditions to obtain an approximate wall-temperature distribution. (auth)

**4672** UNSTEADY NATURAL CONVECTION IN THE VICINITY OF A DOUBLY INFINITE VERTICAL PLATE. J. A. Schetz (General Applied Science Labs., Inc., Westbury, N. Y.) and R. Eichhorn. J. Heat Transfer, 84: 334-8(Nov. 1962).

The viscous flow equations for the unsteady free convection of a fluid near a doubly infinite vertical plate whose temperature or heat flux is an arbitrary function of time are treated by means of Laplace transforms. Exact solutions are obtained for several typical examples with arbitrary Prandtl number. The results are then generalized to give integral expressions for the velocity and temperature fields due to any prescribed time variation in wall temperature or surface heat flux. (auth)

**4673** COMBINED FREE AND FORCED-CONVECTIVE FLOW IN VERTICAL CIRCULAR TUBES—EXPERIMENTS WITH WATER AND OIL. G. A. Kemeny and E. V. Somers (Westinghouse Research Labs., Pittsburgh). J. Heat Transfer, 84: 339-46(Nov. 1962).

Heat-transfer and pressure-drop data were obtained for flow of water ($Pr \sim 4$) and oil ($Pr \sim 10^2$) under conditions of combined free and forced convection. Laminar flow results gave heat-transfer correlations of Nusselt number versus the Graetz number and the quotient of the Rayleigh-number-to-Graetz number. Prandtl number dependence appeared minor for all values of $Ra/Gz \lesssim 10^5$ and $Gz \lesssim 10^2$. Nonlaminar flow occurred in the tube distinct from the usual turbulent flow occurring with Reynolds numbers based on tube diameter greater than 3000. The flow was better judged from the pressure drop data to occur whenever the friction factor $f$ exceeded the value of $16/Re$ by 2× to 3×. Increases in heat transfer over the laminar values were marked with this type of flow. Increases in pressure drop over those occurring with laminar flow could not be identified from the data because of lack of a good laminar correlation to permit identification of the difference. The pressure drop data showed marked increases of the friction factor $f$ above the $16/Re$-value, by as much as 20× to 30×. At a fixed value of $Ra/Gz$, larger increases were noted with the smaller Graetz numbers in accord with Hallman's limiting theory. (auth)

**4674** EFFECT OF ARBITRARY NONSTEADY WALL TEMPERATURE ON INCOMPRESSIBLE HEAT TRANSFER. T. R. Goodman (Allied Research Associates, Inc., Boston). J. Heat Transfer, 84: 347-52(Nov. 1962).

The problem is solved using an integral method and ignoring viscous dissipation. A partial differential equation is derived which yields as special cases Lighthill's non-uniform heat-transfer formula and the nonsteady heat conduction in a slab. The differential equation is then specialized to the nonsteady but uniform heat transfer on a flat plate. Comparisons with other solutions are made when available, and it is shown that the integral method produces accuracy of a few per cent in these limiting cases. (auth)

**4675** LAMINAR FORCED CONVECTION OF LIQUIDS IN TUBES WITH VARIABLE VISCOSITY. Kwang-Tzu Yang (Univ. of Notre Dame, Ind.). J. Heat Transfer, 84: 353-62 (Nov. 1962).

Analytical solutions for laminar forced convection of liquids flowing in circular tubes with temperature-dependent viscosity are obtained for both step change in tube-wall temperature and step change in wall heat flux by using an improved integral procedure. The accuracy of this analytical procedure is demonstrated by comparing results for the isothermal problems with that from the exact solutions. Results for the nonisothermal cases are presented in graphical forms in terms of Nusselt numbers, velocity variations at tube center line, and friction factors. Tabulated Nusselt numbers are also given. (auth)

**4676** LAMINAR HEAT TRANSFER IN TUBES UNDER SLIP-FLOW CONDITIONS. E. M. Sparrow and S. H. Lin (Univ. of Minnesota, Minneapolis). J. Heat Transfer, 84: 363-9(Oct. 1962).

The effects of low-density phenomena on the fully developed heat-transfer characteristics for laminar flow in tubes was studied analytically. Consideration is given to the slip-flow regime wherein the major rarefaction effects are manifested as velocity and temperature jumps at the tube wall. The analysis is carried out for both uniform wall temperature and uniform wall heat flux. In both cases, the slip-flow Nusselt numbers are lower than those for continuum flow and decrease with increasing mean free path. Extension of the results is made to include the effects of shear work at the wall, temperature jump modifications for a moving fluid, and thermal creep. (auth)

**4677** FORCED-CONVECTION FILM BOILING ON A FLAT PLATE WITH UNIFORM SURFACE HEAT FLUX. R. D. Cess (State Univ. of New York, Stony Brook). J. Heat Transfer, 84: 395(Nov. 1962).

A very simple approximate analysis is given for forced-convection film boiling, and the specific case of a uniform surface heat flux is used as an example. It is shown that the Nusselt number and skin friction for uniform surface heat flux are greater by a factor of 1.41 than these for constant wall temperature. The analysis can also be applied to any arbitrary variation of surface heat flux. (D.L.C.)

**4678** SOME HOMOLOGOUS FLOWS IN FLUID MAGNETODYNAMICS AND IN GAS DYNAMICS. R. Peyret (Université, Paris). J. Mecan., 1: No. 1, 31-47(Mar. 1962). (In French)

A correspondence for compressible fluid flow with variable entropy is established between flows of conducting fluids exposed to magnetic effects and flows of gas without magnetic effects. The applications considered are developments up to the second order of different flow magnitudes, study of the lift and path of a profile, and similar tube parameters of the flow with Mach number near 1. (J.S.R.)

**4679** VISCOUS FLOW THROUGH POROUS MEDIA. II. APPROXIMATE THREE-POINT CORRELATION FUNCTION. Harold L. Weissberg (Oak Ridge Gaseous Diffusion Plant, Tenn.), and Stephen Prager. Phys. Fluids, 5: 1390-8(Nov. 1962). (TID-15587)

Lower bounds were derived earlier [S. Prager, Phys. Fluids, 4: 1447(1961)] for the resistance of a porous medium to the passage of a viscous fluid. The information required for the calculation of such bounds consists of certain two- and three-point correlations S and G. An approximate expression for G in terms of S is presented and used to calculate the resistance of a bed of widely spaced spheres. The result is about 5% above the resistance calculated using the correct G, which in turn is about 25% below the true value of the resistance. Improved lower bounds on the resistance are available, but have not yet been applied because of the complexity of the calculations involved. (auth)

**4680** APPLICATION OF THE MONTE CARLO METHOD TO HEAT TRANSFER IN A RAREFIED GAS. J. K. Haviland and M. L. Lavin (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 5: 1399-1405(Nov. 1962).

A Monte Carlo method was developed and applied to the heat transfer between two parallel walls in a rarefied gas, using the IBM 709 computer. Three solutions were obtained all at a temperature ratio between the walls of 4 : 1. One was for hard-sphere molecules at a Knudsen number of 2.0, and two were for Maxwellian molecules at Knudsen numbers of 0.53 and 1.64. These results appear to be of sufficient accuracy to differentiate between some of the approximate analytical methods available at present. It is believed that solutions could be obtained to any degree of accuracy, given sufficient time on a high-speed computer. (auth)

**4681** INSTABILITIES OF A LIQUID CONDUCTOR. Uno Ingard and David S. Wiley (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 5: 1500-2(Dec. 1962).

Observations of pinch and spiral instabilities of a liquid conductor falling in an axial magnetic field are reported. Measured rates of change of the stream diameter and the spiral radius are given, and a stream "bifurcation" phenomenon induced by spiral instability is described. (auth)

**4682** COMMENT ON "FLOW OF AN INCOMPRESSIBLE FLUID IN A HYDROMAGNETIC CAPACITOR." W. S. Lewellen (Aerospace Corp., El Segundo, Calif.). Phys. Fluids, 5: 1663-4(Dec. 1962).

It is suggested that an analysis by Chang and Ludgren (Phys. Fluids, 2: 627(1959)) is in error by an undetermined amount as a result of an assumption that the streamlines in an electrically conducting liquid flowing in an axially symmetric annulus terminated by horizontal top and bottom plates have only a tangential component. It is postulated that the boundary layers at the top and bottom surfaces give rise to a radial velocity component of undetermined magnitude. (T.F.H.)

**4683** MAGNETOHYDRODYNAMIC CHANNEL FLOW. Neil James Curlee, Jr. Pittsburgh, Univ. of Pittsburgh, 1961. 84p.

The laminar flow of an electrically conducting incompressible viscous fluid flowing in a rectangular channel in the presence of a transverse magnetic field was analyzed. The particular problem considered was the flow in a channel with magnetohydrodynamic generator boundary conditions. The boundary conditions were: electrically insulating walls perpendicular to the transverse field, and electrically conducting walls parallel to the transverse field. Two coupled partial differential equations linking the velocity and the induced magnetic field parallel to the direction of flow were derived for the flow of an electrically conducting fluid in a channel of unspecified shape. The boundary conditions on the induced magnetic field are shown to be a function of wall conductivity and in the case of a generator, external current. The equation for voltage between the conducting walls was also derived. The method of integral transforms is illustrated using as an example laminar flow in a rectangular channel without electromagnetic forces. The method was then applied to the laminar flow in a rectangular channel with electromagnetic forces and magnetohydrodynamic generator boundary conditions. The transforms could not be found independently of one another and hence a digital computer was used to solve truncated sets of transformed equations. Solutions were obtained with as many as 36 terms in the series for velocity and 36 terms in the series for induced magnetic field. Limiting cases such as; the flow in a rectangular without magnetic forces, the flow in a rectangular channel with magnetic forces but a very large width, and the magnetohydrodynamic generator with zero flow due to external current are discussed. Based on the study of the limiting cases it is shown that the integral transform solution with 36 terms in each series is adequate for channels of approximately equal height and width, Hartmann number of less than 12, and no external current. It is shown further that for the zero flow case the integral transform solution converges to the exact solution. Results presented include average flow per unit pressure drop, voltage between the two conducting walls, and velocity profiles, all as functions of Hartmann number for Hartmann numbers of 12 or less, and no external current. The calculated flow per unit pressure was compared with Hartmann's experimental result for a 1.15 mm × 1.16 mm channel with mercury as the fluid. Agreement was satisfactory. The results are discussed and the electromagnetic body force is shown to be proportional to the partial derivative of the induced magnetic field with respect to distance parallel to the transverse field and also to the electric current perpendicular to the transverse field. (Dissertation Abstr., 23: No. 4, 1962)

**4684** BOILER FOR THE RECOVERY OF THE HEAT OF A FLUID UNDER PRESSURE. (to Babcock and Wilcox Ltd.). British Patent 909,557. Oct. 31, 1962.

A tubulous boiler has been designed to be heated by a heating fluid under pressure. A pressure vessel provides a heating fluid flow path and includes a vapor-liquid separating drum. (R.J.S.)

**4685** IMPROVEMENTS IN OR RELATING TO SELF-SEALING COUPLINGS FOR FLUID FLOW CIRCUITS. Laurence Clive Chumbley (to United Kingdom Atomic Energy Authority). British Patent 909,561. Oct. 31, 1962.

A self-sealing coupling for fluid flow circuits has been designed in which the possibility of spillage during connection and disconnection over a wide range of operating pressures is minimized. (R.J.S.)

**4686** IMPROVEMENTS IN AND RELATING TO THE CONTROL OF STEAM TURBINE PLANTS. John McTaggart and John William Lincoln (to Associated Electrical Industries Ltd.). British Patent 910,677. Nov. 14, 1962.

A system is described for controlling a thermal power plant that includes a heat exchanger for transferring heat from a gas-cooled nuclear reactor to a steam turbine. Methods of controlling flow of the heat transfer mediums are set forth. (R.J.S.)

## Materials Testing

**4687** (ANL-FGF-378) NEUTRON RADIOGRAPHY: A 1962 PROGRESS REPORT. Harold Berger (Argonne National Lab., Ill.). Aug. 17, 1962. Contract [W-31-109-eng-38]. 28p. (UAC-6888)

The possibility of improved detection discrimination between selected materials; the high absorption of several light materials such as hydrogen, lithium, and boron; and the relatively low absorption of many heavy materials are some characteristics which make neutron radiographic inspection attractive as a complementary technique to x-radiography. A study of neutron radiography is reported in which the emphasis has been placed upon determining many of the characteristics of various techniques for detecting neutron images. Characteristics of photographic detectors for thermal neutron images are outlined. (R.J.S.)

**4688** SOFT GAMMA RADIOGRAPHY WITH MINIMUM HAZARD RADIOISOTOPE. James C. McCue (Edgerton, Germeshausen and Grier, Inc., Boston). Nondestructive Testing, 20: 383-6(Nov.-Dec. 1962).

An inert radioactive gas was employed as an excitation source for low-energy fluorescent x-rays. The optimum source fabrication is described, and the specifications of several sources presented. The feasibility of utilizing the sources for soft gamma radiography was successfully demonstrated, and typical examples are given. A discussion of the parameters influencing radiograph quality attainable with the sources considers both their limitations and capabilities. An outstanding feature of the technique is the reduction of leakage hazards attributable to a unique packaging method for the biologically inert gas. Potential applications and areas of further development are suggested. (auth)

**4689** AN EDDY CURRENT TECHNIQUE FOR MEASURING THE TUBE-TO-TUBE ANNULUS IN A NUCLEAR TEST REACTOR. J. C. Spanner (General Electric Co., Richland, Wash.). Nondestructive Testing, 20: 394-7; 400 (Nov.-Dec. 1962).

An eddy current technique, which was developed to measure the annulus between two concentric tubes in a nuclear reactor, is described. Physical considerations dictated the measurement be made with a sensing element capable of traversing the inside of an inner Zircaloy-2 tube, seeing through the relatively thick walls of the tube, and detecting small relative displacements of an outer aluminum tube. Given a constant inner tube wall thickness, the instrument is capable of measuring tube-to-tube displacements with an accuracy of ±0.002 in., throughout the full displacement range of 0.550 in. The equipment exhibits very little d-c drift and, under ideal conditions, has detected relative tube displacements as small as 0.0005 in. The instrument consists of a four-coil probe assembly with its associated balance and switching circuitry, and a commercial eddy current tester, which was modified for the application. (auth)

# GEOLOGY, MINERALOGY, AND METEOROLOGY

*Refer also to abstracts 4865, 5060, and 5061.*

**4690** (DXRL-F5) FALLOUT IN NEW ZEALAND AND PACIFIC ISLAND TERRITORIES. Quarterly Report, April—June 1962. (New Zealand. Dominion X-Ray and Radium Lab., Christchurch). 47p.

An account is given of monitoring activities in the Pacific Islands during the series of tests of nuclear weapons that started in the Christmas Island area on April 26, 1962. In addition, measurements of total beta activity in air filters and rain samples at Christchurch and levels of strontium-90 in New Zealand rain and milk are given. While the report on routine observations at New Zealand stations is confined to the period ending on June 30, 1962, the account of monitoring activities in the Pacific area covers the period immediately preceding the resumption of the weapon tests in the Pacific to the latest results available up to the end of October 1962. (R.J.S.)

**4691** (NP-12286) HEBGEN LAKE EARTHQUAKE. Long Range Seismic Measurements [of] VELA-UNIFORM Project 8.4. (Geotechnical Corp., Garland, Tex.). Feb. 25, 1962. 41p.

Basic seismic data concerning an earthquake which occurred near Hebgen Lake, Montana, on Feb. 25, 1962, are presented. (J.R.D.)

**4692** (UCRL-13054) FEASIBILITY STUDY OF ROCKET AND LAUNCHING SYSTEMS FOR PARTICULATE SAMPLING OF CLOUDS. A. G. McLaughlin, Fred S. Soltis, and Bruce R. Walker (Zimney Corp., Monrovia, Calif.). Sept. 30, 1962. For Univ. of California Lawrence Radiation Lab., Livermore. Contract W-7405-eng-48, Subcontract 201. 60p.

Methods for improving and expanding a particulate sampling system to increase its utility are discussed. Included are refinements in design of the system, alternate vehicles used as carriers, trajectories, launching methods, tracking systems, and cost-time schedules. (auth)

**4693** RADIOCHEMISTRY OF METEORITES. Oliver A. Schaeffer (Brookhaven National Lab., Upton, N. Y.). Ann. Rev. Phys. Chem., 13: 151-70(1962).

A review is presented of the radioactive and stable nuclides produced in meteorites by cosmic rays. The question of constancy of cosmic rays in time and space is considered along with the exposure ages of meteorites. (D.L.C.)

**4694** METEOROLOGICAL INFORMATION TO BE COLLECTED BEFORE STARTUP OF A REACTOR. G. Fea, D. Fedele, B. Pavesi, A. Persano, E. Rosini, L. Santomauro, C. Sennis, and S. Tagliati (Comitato Nazionale Energia Nucleare, Rome). Comit. Naz. Energia Nucl., Notiziario, 8: 10-14(Feb. 1962). (RT/PROT(62)6). (In Italian)

An analysis is presented concerning meteorological and climatological investigations to be conducted before the start-up of a new reactor. Reactors are divided into two classes on the basis of the radioactive effluents released into the atmosphere. According to the class of the reactor, specific or general criteria are proposed for the type and the extent of information to be collected, the instrumentation to be used, and the presentation of data. Some examples, relative to typical locations, are discussed. (auth)

**4695** CORRELATION BETWEEN THE URANIUM CONTENT OF MARINE PHOSPHATES AND OTHER ROCK CONSTITUENTS. Fathi Habashi (Technische Hochschule, Vienna). Econ. Geol., 57: 1081-4(Nov. 1962).

Sulfate and uranium appear to be genetically related in phosphorites. From the analysis of seven samples of sedimentary phosphates of different origin, it was found that the uranium content increases with decreasing sulfate content. This is attributed to the formation of sulfate complexes of uranium during sedimentation processes. The increase of uranium content with increasing $P_2O_5$ content previously reported in the literature was verified. A sample of magmatic phosphate was found not to behave in a manner similar to the sedimentary phosphate. (auth)

**4696** THE DISTRIBUTION OF THORIUM, URANIUM, AND POTASSIUM IN THE MANCOS SHALE. R. Pliler and J. A. S. Adams (Rice Univ., Houston, Tex.). Geochim. Cosmochim. Acta, 26: 1115-35(Nov. 1962). (In English)

Over 135 samples of upper Cretaceous Mancos shale were analyzed for uranium, thorium, and potassium by chemical and radiometric means. The samples were collected from 16 localities in Colorado, Utah, Arizona, and New Mexico. The average concentrations found in the Mancos shale samples were 10.2 ppm thorium, 3.7 ppm uranium, and 1.9% potassium as metal. The average Th/U ratio was 3:1. For the most part, variations in the thorium, uranium, and potassium concentrations were gradual and took place over large distances. Thorium, Th/U ratio, and potassium tended to decrease and uranium tended to increase with distance from the upper Cretaceous shoreline. The K/Th ratio in the shale, including sandy intertongues, showed remarkedly little variation on a regional basis. Laboratory studies indicated that the uranium in the Mancos shale was present largely in the fine-grained primary resistate minerals, and the thorium occurred in the fine-grained secondary resistates or fixed in or on clays. (auth)

**4697** THE DISTRIBUTION OF THORIUM AND URANIUM IN A PENNSYLVANIAN WEATHERING PROFILE. R. Pliler and J. A. S. Adams (Rice Univ., Houston, Tex.). Geochim. Cosmochim. Acta, 26: 1137-46(Nov. 1962). (In English)

Eleven samples representing a pre-Pennsylvanian weathering profile on the Boulder Creek granodiorite near Boulder, Colorado, were analyzed for thorium and uranium by $\gamma$-ray spectrometric and chemical methods. In an effort to determine the possible sites of thorium and uranium in the samples, a study of their leachability in hot 2 $\underline{N}$ hydrochloric acid was undertaken. Fresh granodiorite was found to contain 9.3 ppm thorium and 2.5 ppm uranium. The first stages of weathering resulted in an apparent removal of 25% of the thorium and 60% of the uranium present in the original granodiorite. The leaching study of the fresh granodiorite demonstrated that as much as 90% of the thorium and 60% of the uranium could be removed by an acid leach solution. This seems to indicate that most of the thorium and uranium in the fresh rock is situated in acid soluble minerals or in interstitial materials. After the initial drop of the concentration in the lowest part of the weathered mantle, the total uranium and thorium content of the weathered rock increased by a factor of at least 4 in the uppermost, most-weathered rock material. Leaching studies of the weathered rock indicated that uranium is present largely in the primary resistates, such as zircon, xenotime, and apatite, and thorium occurs mainly in or on clays or in the secondary resistates—minerals formed during weathering. (auth)

**4698** THE BERYLLIUM CONTENT OF SOME METEORITES. Claude W. Sill and Conrad P. Willis (Idaho Operations Office, Health and Safety Div., AEC). Geochim. Cosmochim. Acta, 26: 1209-14(Nov. 1962). (In English)

The beryllium concentration of 17 meteorites was determined with excellent precision by a fluorometric procedure using morin as reagent. The average concentration found for 13 chondrites and 1 achondrite was 0.038 ppm or 0.64 atom per $10^6$ atoms of silicon. Two other achondrites were excluded from the average because of their large deviations from the mean. The only iron meteorite analyzed contained less than 1 ppb as expected. One sample each of a diabase, basalt, granite, and shale showed an increasing quantity of beryllium in the order given compared to the meteorite average, ranging from about 16 times for the diabase to 160 times for the shale. Values of 2.74 ± 0.03 ppm and 0.623 ± 0.006 ppm were obtained for the standard rock samples G-1 and W-1, respectively. (auth)

**4699** ON THE MECHANISM OF MASS AND RADIOACTIVITY TRANSPORT FROM STRATOSPHERE TO TROPOSPHERE. D. O. Staley (Univ. of Arizona, Tucson). J. Atmospheric Sci., 19: 450-67(Nov. 1962).

Periodic mass transfer by extratropical disturbances and periodic debris concentration at the tropopause are introduced into a simple expression for debris transfer. The resulting expression shows the variation of debris transfer into the troposphere throughout the year as a function of individual variable factors. Measurements of vertical motion and trajectories and of beta activity below, within, and above several dry tropospheric baroclinic zones associated with extratropical disturbances are interpreted to test the proposed transfer mechanism. The observed evidence shows that downward mass and radioactivity transport by individual baroclinic disturbances is the most important transport mechanism and allows prediction of specific regions of mass and radioactivity flow into the troposphere. (H.D.R.)

**4700** RADIONUCLIDES IN GROUNDWATER AT THE SAVANNAH RIVER PLANT WASTE DISPOSAL FACILITIES. S. O. Reichert (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Geophys. Res., 67: 4363-74(Oct. 1962).

At the Savannah River Plant, disposal of radioactivity to the ground has been limited to the burial of solid waste and the discharge of very-low-level waste to open seepage basins. Although solid wastes have been subjected to leaching by an annual rainfall of 45 to 50 inches since 1953, no radionuclides have been detected in groundwater from this source. Seepage basin retention of radionuclides has been less satisfactory. All of the radionuclides released to the seepage basins, except plutonium, have been detected in the surrounding groundwater. Fission-product tritium, present in water, is not adsorbed and thus serves as a useful groundwater tracer. Strontium 90 is poorly adsorbed on local soil (under the acidic conditions usually present in seepage basins), and is detectable in sand layers, at concentrations less than the Radioactivity Concentration Guide, as far as 500 feet from the basins. The radionuclides of cerium, cesium, ruthenium, zirconium, and niobium do not migrate as far as those of strontium. The path of radionuclide migration from seepage basins is determined by the geology and hydrology of each area. Most of the migration of radionuclides has been through sandy strata or sand-filled clastic dikes. Wherever the soils do not contain these imperfections, migration has been slow. (auth)

**4701** MONTHLY WIND MEASUREMENTS IN THE MESODECLINE OVER A ONE-YEAR PERIOD. Lawrence B. Smith (Sandia Lab., Albuquerque, N. Mex.). J. Geophys. Res., 67: 4753-72(Nov. 1962).

Variations in winds between altitudes of 180 and 275 kilofeet are shown over a 1-year period as a result of 38 observations made at the Tonopah test range in Nevada. These observations were made by radar tracking of chaff ejected from small two-stage rockets above 300 kilofeet. Two to four measurements were made one day each month throughout the year except during February and October. Measurement accuracy, fall behavior from free fall to terminal velocity, seasonal distributions, annual variations, and vertical wind shear statistics are discussed. Negative results were obtained in efforts to correlate periodicities with tidal motions and in attempts to quantify turbulence directly. However, the vertical scale of turbulence from correlation curves is found to vary from about 25 kilofeet in winter to 45 kilofeet in summer. The decay of correlation curves is compared with those from other altitude zones. Root mean square variations of turbulence estimated from the radar track are approximately 21 knots. (auth)

**4702** ISOTOPIC DISPLACEMENTS IN METEORITES AND THE EARLY HISTORY OF OUR PLANETARY SYSTEM. W. Gentner (Max-Planck-Institut für Kernphysik, Heidelberg). Umschau Wiss. Tech., 62: 566-70(Sept. 15, 1962). (In German)

The origin of isotopic displacement in meteorites is summarized, and the significance of this displacement with respect to the cosmic radiation constant, the radiogenic age, and the beta radiation age is indicated. The decreasing radioactivity of meteorites and the primary rare gases are discussed. (J.S.R.)

**4703** ADVANCES IN GEOPHYSICS. VOLUME 9. H. E. Landsberg and J. Van Mieghem, eds. New York, Academic Press, 1962. 381p. $14.50.

Six papers are included in this volume. One paper, entitled "Effects of Trapped Particles on the Geomagnetic Field," was abstracted separately for NSA. The titles of the other five papers, not abstracted separately, are as follows: "The Focal Mechanism of Earthquakes"; "Properties and Processes at the Earth's Surface in Relation to the General Circulation of the Atmosphere"; "Identification of Aerosols"; Celestial Geodesy"; and "The Problem of the Mantle-Crust Mix: Lateral Inhomogeneity in the Uppermost Part of the Earth's Mantle." (L.T.W.)

**4704** EFFECTS OF TRAPPED PARTICLES ON THE GEOMAGNETIC FIELD. John R. Apel (Johns Hopkins Univ., Silver Spring, Md.), S. Fred Singer, and Robert C. Wentworth. Advan. Geophys., 9: 131-89(1962).

There are diverse opinions on many of the details of magnetic storms but on the whole, the interconnections between solar flares, aurorae, magnetic storms, and associated processes are suspected, if not understood. It is shown how charged particles, when trapped in the earth's magnetic field, can perturb that field. It is suggested that these distortions are the cause of the main phase of magnetic storms and of the large departures from the theoretical geomagnetic field which have been observed during the flights of several space probes. (W.D.M.)

**4705** SUMMARY OF ROCK SALT DEPOSITS IN THE UNITED STATES AS POSSIBLE STORAGE SITES FOR RADIOACTIVE WASTE MATERIALS. W. G. Pierce and E. I. Rich (Geological Survey, Washington, D. C.). Geological Survey Bulletin 1148. 1962. 96p., 6 illus. (GPO)

Cavities in salt beds offer an attractive means of disposal of radioactive wastes. For reference purposes, information on the geology of salt and the distribution, thickness, and depth below the surface of all the known rock salt deposits of the U. S. are assembled. Salt reserves and production, and the development of underground cavities for storing liquefied petroleum gas are discussed briefly. (D.L.C.)

**4706** NEW APPROACHES TO GEOCHRONOLOGY BY STRONTIUM ISOTOPE VARIATIONS IN WHOLE ROCKS. P. M. Hurley, H. W. Fairbairn, G. Faure, and W. H. Pinson, Jr. (Massachusetts Inst. of Tech., Cambridge). IAEA Preprint No. SM-33/6. 3p. (In English)

To be published in Proceedings of the IAEA Symposium on Radioactive Dating, Athens, Greece, 19-23 November 1962.

Conventional methods of geochronology using K-Ar, Rb-Sr, U-Pb relationships in separated mineral phases are seriously limited through loss of daughter isotopes during the cooling history of the rock. $Sr^{87}$ lost from Rb-rich mineral phases appears, however, to remain in the rock as a whole, so that whole-rock Rb-Sr age measurements seem to be generally free of this limitation. It is essential with this procedure to know the initial $Sr^{87}/Sr^{86}$ ratio in the system and, if the rock has any lithologic complexity, to know something of its history. These requirements were studied and methods of satisfying them appear to be achievable. The measurement of whole-rock ages and initial values of $Sr^{87}/Sr^{86}$ in materials of the sialic crust leads to a determination of the genesis of the material if the ratio of $Sr^{87}/Sr^{86}$ in possible source materials is known. A study of this ratio in mantle source regions indicates values in almost all cases between 0.706 and 0.709 for a wide range of igneous rocks believed to be derived from these regions. Crustal materials including sediments rapidly develop higher ratios owing to a severalfold enrichment in Rb. It is therefore possible in the crystalline basement rocks of the continents to determine the proportion of reworked crustal material relative to new additions of sialic material from deep non-sialic source regions. It was found so far that the major proportion of sialic basement is composed of new material with no previous sialic history; the minor proportion is reworked crustal material. It is possible to date the rise of the primary sial in most cases. With this greater insight into the genesis of igneous and metamorphic rocks it is possible to apply the whole-rock Rb-Sr method more generally without determining the initial ratio of $Sr^{87}/Sr^{86}$ each time by isochron plot, by utilizing the ubiquitous source region value of 0.708 ± 0.001. Knowledge of the true age of intrusion at depth by this whole-rock method permits the interpretation of the generally lower ages of separated minerals in terms of the subsequent cooling and uplift history of the rock body. The difference between the true age of intrusion and the ages shown by conventional methods on separated minerals is found to be as great as several hundred m.y. in some Pre-Cambrian shield areas. (auth)

**4707** DATING METHODS BASED ON THE PROCESS OF NUCLEAR FISSION. P. K. Kuroda (Univ. of Arkansas, Fayetteville). IAEA Preprint No. Sm-33/10. 11p. (In English)

To be published in Proceedings of the IAEA Symposium on Radioactive Dating, Athens, Greece, 19-23 November 1962.

The xenon-plutonium age of the earth, i.e. the time interval ($\Xi$) between cessation of nucleosynthesis and formation of the earth, was calculated from the inventories of fissiogenic $Xe^{136}$ in the earth atmosphere and uranium in the earth's crust and mantle, assuming that the extinct $Pu^{244}$ has contributed to the production of the fission products. The xenon-plutonium age of the earth appears to be in general agreement with the xenon-iodine age. The $Xe^{129}/Xe^{136}$ age ($\Xi$) of the earth was calculated from the ratio of radiogenic $Xe^{129}$ to fissiogenic $Xe^{136}$ in the earth atmosphere to be 129 to 225 million years. A series of experiments were carried out in which the fission products/$U^{238}$ ratios in non-irradiated uranium salts and in pitchblende were measured as accurately as possible. The spontaneous fission half life of $U^{238}$ was calculated from these data to be $8.0 \times 10^{15}$ years. The $Sr^{90}/U^{238}$ ratio in a 10-year old uranium salt was found to be considerably smaller than that in pitchblende, indicating that the secular equilibrium is not established in the former. By measuring the levels of fission products, such as $Pm^{147}$, $Sr^{90}$, and $Tc^{99}$, in uranium salts and ores, it is hoped to develop a method for dating the time of formation of the uranium-bearing materials with up to several million years of age. The problem of testing the constancy of the neutron flux during the geological past of the earth was investigated by measuring the ratio of long-lived fission products/uranium in pitchblende. $Tc^{99}$ was isolated from kilogram quantities of pitchblende and the activity was measured. The results indicated that $Tc^{99}$ was produced in the uranium ore predominantly by the spontaneous fission of $U^{238}$ and the neutron flux in the ore body remained more or less constant during the past million years or so. (auth)

**4708** RADIOACTIVITIES IN METEORITES AND IN SATELLITES. E. L. Fireman, J. De Felice, and D. Tilles (Smithsonian Astrophysical Observatory, Cambridge, Mass.). IAEA Preprint No. SM-33/11. 15p. (In English)

To be published in Proceedings of the IAEA Symposium on Radioactive Dating, Athens, Greece, 19-23 November 1962.

Measurements of radioactivities in meteorites and in recovered satellites made at the Smithsonian Astrophysical Observatory are summarized. These include: tritium, argon-37, and argon-39 in the recent falls, Hamlet, Aroos, Bruderheim, Harleton, and Ehole; tritium, argon-37, and argon-39 in separated phases of the Bruderheim and Harleton; tritium and argon-37 in material from Discoverers 17, 18, 26, and 36, and xenon radioactive isotopes in Discoverer 17 and 36 materials. These measurements are compared to target results. The tritium and argon-39 contents in various stony meteorites differ by less than a factor of two. The tritium content of iron meteorites and of the metallic phase of stony meteorites are in some cases much lower than would be expected from the argon-39 contents. This result indicates tritium diffusion loss from the metal of some meteorites. The argon-37 to argon-39 ratio in separated phases of meteorites indicates spatial constancy of cosmic rays and a contribution from elements other than iron to the argon-37. In Discoverer 17 materials, the very large tritium contents and its steep depth variation can be interpreted only on the basis of tritium being present in at least 0.4% concentration in the Nov. 12, 1960, solar flare. The argon-37 and xenon radioactivities in the satellite materials can be interpreted on the basis of interactions with galactic cosmic rays and with Van Allen protons. (auth)

**4709** DATING OF SOME PITCHBLENDES AND URANINITES FROM YUGOSLAV LOCALITIES BY $Pb^{206}/Pb^{210}$ METHOD. S. Gojković, G. Deleon, and Z. Červenjak (Inst. of Nuclear Research, Belgrade). IAEA Preprint No. SM-33/14. 7p. (In English)

To be published in Proceedings of the IAEA Symposium on Radioactive Dating, Athens, Greece, 19-23 November 1962.

The determination of the concentration of $Pb^{210}$ was carried out by two independent methods, the measurement of the intensity of 47-kev gamma ray by a gamma ray scintillation spectrometer and the measurement of $Bi^{210}$ beta activity by liquid scintillation technique. Although the first one is not as sensitive as the second, it has some marked advantages due to the fact that the material is not lost, the sample is not so easily contaminated and it is not necessary to have the $Pb^{210}/Bi^{210}$ system in equilibrium. Compared with the earlier described techniques for the determination of $Pb^{210}$, measurement of 47-kev gamma ray represents a superior purity check of lead separation. All measurements were performed on the lead extracted from several samples of uraninites and pitchblendes from two different localities in Yugoslavia and the obtained $Pb^{206}/Pb^{210}$ age values are in close agreement with the values obtained by other methods. (auth)

**4710** AGE DETERMINATION ON SECONDARY URANIUM-MINERALS IN NORTH BAVARIA. H. Lenz and I. Wendt (Bundesanstalt für Bodenforschung, Hannover). IAEA Preprint No. SM-33/20. 10p. (In English)

To be published in Proceedings of the IAEA Symposium on Radioactive Dating, Athens, Greece, 19-23 November 1962.

Several samples of secondary uranium minerals, mainly torbernite and autunite, were dated by the $Pb^{206}/U^{238}$, the $Pb^{207}/U^{235}$, and the RaD methods. Concordant ages of $15 \times 10^6$ and $7 \times 10^6$ years were obtained. These dates could be confirmed by several samples from the same zone of mineralization. It is shown that the formation of these U minerals occurred in recent times and is not in connection with the general geological activity in this area. (auth)

**4711** K-A-MEASUREMENTS OF TEKTITES. J. Zaehringer (Max-Planck-Institut für Kernphysik, Heidelberg, Ger.). IAEA Preprint No. SM-33/37. 12p. (In English)

To be published in Proceedings of the IAEA Symposium on Radioactive Dating, Athens, Greece, 19-23 November 1962.

Previously reported K-Ar-age determinations were extended. Tektites from Georgia, Martha's Vineyard, six specimens from Texas, seven Moldavites, 20 specimens from the Indochinese-Australian area, and two samples of the Ivory Coast were analyzed with improved technique. Tektites containing bubbles are of special interest and samples with rare gases of other than radiogenic origin were found. In addition, glasses of various craters as well as Libyan Desert glass and Darwin glass were investigated. The results show that all North American tektites, the Moldavites, and the Indochinese-Australian tektites form conclusively three groups of 34, 15, and 0.6 my. The Ivory Coast tektites are very similar to the latter group. The origin of tektites is discussed. (auth)

**4712** AGE STUDIES ON BASALTIC LAVA FLOWS USING NATURAL ALPHA ACTIVITY AND THERMOLUMINESCENCE. B. E. Sabels (Univ. of Nevada, Reno). IAEA Preprint No. SM-33/42. 20p. (In English)

To be published in Proceedings of the IAEA Symposium on Radioactive Dating, Athens, Greece, 19-23 November 1962.

Basaltic lava samples of ages from 15 years to 15 million years were collected in Arizona and Europe, utilizing extensive geologic literature. The samples were measured for alpha activity and natural and x-ray induced thermoluminescence. Supporting tests for sampling reliability, for effects of grinding, annealing, and radiation saturation were carried out. The data were first reported in the unpublished dissertation of the writer (1960). Young lavas give glow areas in correspondence with age and alpha activity. For older lavas, any relationship between age and glow is lacking. Therefore, the existence of thermoluminescent decay is deduced. The simplified decay equation involving natural glow and alpha activity is solved and is shown to be in good agreement with field evidence on northern Arizona basaltic lavas of 900 to 35,000 years of age. A hypothetical half life of thermoluminescent decay for these lavas is calculated to be 20,000 years. Samples from one lava source show satisfactory reproducibility and indicate the existence of several age units of lava, in keeping with field evidence. For highly alpha-active samples, the x-ray induced glow increases in proportion with the x-ray dose. Contrary, low-activity samples of young age show saturation effects for x-ray induced glow. These saturation phenomena in young, raw basalts give a clue as to their usefulness for age studies. Grain-size tests indicate tribo-effects and the need for standardized grinding procedures. European samples from the historic flows of Vesuvius can be arranged in order of their known age by thermoluminescence and alpha activity studies. But single specimens from a variety of volcanic fields cannot be correlated and interpreted for age. Tertiary samples yield small glow areas. It appears that basaltic lavas can be estimated for their age by thermoluminescence and alpha activity measurements under the following conditions: (1) A large number of lava samples from related flows of different age, yet similar composition, must be collected. (2) The age of at least one flow must be know a priori. (3) The age of the lava flow(s) which are to be determined should lie within $0 \leq t \leq 2T$, where T is the half life of thermoluminescent decay and can be calculated from (1) and (2). The method suggests itself for application in thorough, interdisciplinary studies of specific volcanic fields. It is not good for the "dating" of single specimens. (auth)

**4713** RADIOCARBON DATING OF DEEP WATER OF THE PACIFIC AND INDIAN OCEANS. G. S. Bien, N. W. Rakestraw, and H. E. Suess (California. Univ., La Jolla). IAEA Preprint No. SM-33/13. 12p. (TID-17362)

To be published in IAEA Proceedings of the Symposium on Radioactive Dating, held in Athens, Greece, November 19-23, 1962.

Measurements of profiles of the radiocarbon concentration at various depths, taken at five different locations in the Pacific, show that the radiocarbon concentration is essentially constant below 1000 meters with a slight tendency toward a possible small increase near the bottom of the ocean. In one case a more pronounced minimum in the radiocarbon content was found at a depth of about 2000 meters. Further investigation will have to show if this is a more general feature. The radiocarbon age difference between water from around 40°S and 40°N is about 400 years. This corresponds to a northward component of the velocity of the water of about 0.05 cm/sec. The actual travel time may well be somewhat larger, because of the possible addition of carbon-14 through oxidation of particulate organic matter near the ocean floor. Hence the velocity of the water movement may be somewhat smaller, and perhaps of the order of 0.03 cm/sec. Radiocarbon in deep water of the South Indian Ocean shows slightly higher values than in deep water from the Pacific of comparable latitude. This is in agreement with the assumption that the deep water originates in the Weddel Sea. The rate of eastward movement from the Weddel Sea to the South Pacific seems to be smaller than that for the northward water movement in the Pacific Ocean. Carbon-14 measurements in the surface water show that a definite increase in carbon-14 has taken place since 1958, due to the uptake of bomb-produced carbon-14 from the atmosphere. The increase, however, varies greatly from location to location and is larger than one would expect if the water above the thermocline mixes rapidly. The carbon-14 results lead to the same conclusion as those of tritium measurements from surface water; namely, that the water above the thermocline takes several years to mix and that the uptake of artificial carbon-14 and tritium by the ocean over a period of one or two years affects only a thin surface layer. (auth)

**4714** GEOLOGY AND URANIUM DEPOSITS OF THE COLORADO PLATEAU. Anthony Luke Payne. Thesis, Stanford, Calif., Stanford Univ., 1962. 287p.

All available geologic materials have been assembled; areal geological mapping stratigraphic studies, structural interpretations, distribution and character of mineralization, and mineralogy of the ores. Certain broad characteristics common to uranium deposits in general indicate that many of the theories proposed for the genesis of the ores are not adequate, and that one concept satisfactorily explains most, if not all, of the uranium mineralization of the Colorado Plateau. (Dissertation Abstr., 23: No. 4, 1962)

**4715** TRANSPORT OF RADIOISOTOPES IN LAKES. Gene Elden Likens. Thesis, Madison, Wisc., Univ. of Wisconsin, 1962. 191p.

Limnological investigations were conducted in three Northwestern Wisconsin lakes during 1958-1961. Radiotracer experiments were conducted in Stewart's Dark Lake to determine if water movements were occurring in the supposedly stagnant monimolimnion. A rapid and symmetrical horizontal dispersal of the radiotracer ($Na^{24}$) at an average rate of 16-18 m/day was observed in the monimolimnion in replicated experiments during July 1959 and 1960. However, no appreciable vertical movement was observed during the experimental periods. The pattern of lateral transport of $Na^{24}$ in the monimolimnion was thought to be owing mainly to horizontal turbulent flow with dampened vertical mixing. Sodium-24 was also used to measure the physical transport in an ice-covered lake (Tub Lake). The radiotracer was dispersed horizontally at a maximum distance of 15-20 m during the first 24 hours of replicated experiments conducted in January of 1960 and 1961. Subsequent horizontal displacement was somewhat slower, but reached a maximum distance of almost 30 m from the release point in 3 days. The dispersal pattern was asymmetrical and different in each of the two experiments. Some vertical movement was indicated by the results, but it was apparently of very low velocity. Various sources of energy which might be capable of producing the observed water movement included: heat in the bottom sediments, external changes in temperature and pressure affected by solar radiation and wind, and exchange of ions across the mud-water interface producing unstable differences in the density of the water. The relative importance of each of the forces in the different experiments (summer and winter) is unknown. A crushing device for breaking a container of radioactive solution in deep water, and a portable scintillation counting system are described. Preliminary studies in Stewart's Dark Lake showed that dipteran midges were capable of transporting measurable quantities of radioiodine ($I^{131}$) from the deep water of this lake to the shoreline. The radioiodine was first detected in samples collected in lighted shoreline traps, 20 days after its introduction into the lake. However, precise quantitative measurements of amounts and rates of radionuclide transport were not possible with the sampling techniques used. Incidental to the study of biological transport of radioactive materials was the observation that the most abundant forms encountered in the plankton in Stewart's Dark Lake were *Chaoborus* larvae and *Daphnia*. The *Chaoborus* were concentrated in the upper 4 m of water at all times during a 24-hour sampling period on 1-2 July 1960. The *Daphnia* were restricted to the upper 1 m of water. Studies of the radioactive background from bottom sediments were made in Stewart's Dark and Tub Lakes. The radioactivity emanating from these sediments had a seemingly anomalous pattern in both lakes. Consistently higher concentrations of radioactivity were found along the shoreline than in the deep-water sediments. Various hypotheses are suggested to explain the origin of the radioactivity and its possible environmental role. (Dissertation Abstr., 23: No. 4, 1962)

**4716** POSSIBLE THERMONUCLEAR ACTIVITIES IN NATURAL TERRESTRIAL MINERALS. Titus Pankey, Jr. Thesis, Washington, D. C., Howard Univ., 1962. 52p.

Possible evidences of thermonuclear activities in natural minerals were examined critically. Even though the perfection of controlled thermonuclear fusion devices proved to be a formidable problem, little reason was found to believe that nature would not prevail here, too. One of the most probable sources of natural thermonuclear activity was thought to be the thermal-spike, in which disordered areas created in the lattices of minerals by decaying radioactive nuclei that have been included in the lattices as impurities reach temperatures of $10^5$ to $10^6$ degrees for approximately $10^{-11}$ seconds. As temperatures of this magnitude are barely sufficient to create extensive nuclear fusions even among the lightest atoms, it was concluded that only reactions of the resonant type demanding low energies of activation should be sought. A study was made of the impurity contents of several minerals including zircon, pitchblende, and cyrtolyte, since occasional fusion reactions of this type taking place over periods of the order of geological time would leave accumulations of by-products that could lead to the detection of the processes. Of the natural minerals studied, zircon was particularly interesting, as correlations could be drawn between the iron content of the mineral and the total alpha particle damage and recoil lattice damage by decaying uranium and thorium nuclei. It was also found that the radioactive inclusions in Zircon were often surrounded by iron halos. Some of the iron content of these samples was thought to be the by-product of fusion reactions in the thermal spike, possibly the fusion of two silicon atoms into one iron atom in a low energy process. In support of the proposed silicon-iron reaction, parallels were drawn between the reaction and the well-known iron peak anomaly in cosmic abundance ratios. Attention was also directed to the earth's iron core, and the iron core of the planet Venus. It was shown that the sedimentary fractionation proposed to explain the large accumulations of iron were not entirely satisfactory, and that a possible fusion mechanism, creating the iron at the time of formation of the planets, was not infeasible. Experimental evidences in the form of magnetic analyses, iron analyses, and alpha damage determinations on several minerals were used to support the hypothesis. Magnetic susceptibility measurements were especially helpful, as any appreciable change of the iron content in zircon was reflected by a large change in the magnetic susceptibility. Tests made on neutron bombarded zircon were not conclusive, but a slight increase in iron content with increasing total integrated flux to which the samples were exposed was noted. It was concluded that even though the findings were not definite, they were sufficiently positive to warrant further extensive studies, and perhaps elaborate experimentation, in the search for natural thermonuclear activities. (Dissertation Abstr., 23: No. 4, 1962)

**4717** THE SEPARATION AND MEASUREMENT OF $Al^{26}$ AND $Be^{10}$ IN METEORITES. E. H. Crevecoeur (Louvain, Belgium. Université) and O. A. Schaeffer (Brookhaven

National Lab., Upton, N. Y.). IAEA Preprint SM-33/17. 7p. (TID-17365)

For presentation at IAEA Symposium on Radioactive Dating, held at Athens, Greece, November 19-23, 1962.

Aluminium and beryllium have been separated in various ferrous meteorites. The long half-lives of the isotopes Al$^{26}$ and Be$^{10}$ make it possible to get information dating very far back in time. The substances are obtained pure by conventional chemistry. The wanted elements are separated from the meteorite solution by successively eliminating the contaminants; iron, cobalt, titanium, vanadium, etc., are separated by extraction, chromatography, or precipitation. The aluminium and beryllium and some rare earths are completely precipitated using cupferron of pH 4.7. To separate the aluminium from the beryllium the former is precipitated as chloride using 8-hydroxyquinoline. The beryllium is purified by extraction and precipitation in the presence of EDTA. The substances are analysed qualitatively by spectrography. The yield is determined quantitatively by gravimetric methods. Since these elements give no gaseous products at ordinary temperatures, the measurements will be made on solid specimens using proportional window counters. The results show that cosmic radiation has been constant for ten million years. (auth)

**4718** NATURAL VARIATIONS IN THE RATIO OF U$^{234}$ TO U$^{238}$. D. L. Thurber (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). IAEA Preprint SM-33/12. 11p. (TID-17377)

For presentation at the IAEA Symposium on Radioactive Dating, held at Athens, Greece, November 19-23, 1962.

Although U$^{234}$ has a good half life (250,000 years) for Pleistocene dating, it was previously ignored because no reasonable mechanism for separation from its parent, U$^{238}$, seemed to exist. The report of enrichment of U$^{234}$ in ground waters and secondary minerals by several Russian workers suggests that this possible chronometer be seriously considered. Using $\alpha$ spectrometry the U$^{234}$/U$^{238}$ activity ratios of carbonate deposits from two glacial lake basins and a few selected marine samples were measured. Modern ocean water has an $A^{U^{234}}/A^{U^{238}}$ ratio of 1.15 based on four samples from the Pacific and Atlantic. Since the experimental error on these measurements is about two per cent, the residual anomaly should be detectable in samples up to one million years old, providing a dating method through a period of time not heretofore covered by physical means. Unrecrystalized coral from an Eniwetok drill hole gave ages based on U$^{234}$/U$^{238}$ ratios in agreement with other methods. The oldest sample, dated as Miocene by paleontologists, was in radioactive equilibrium. Thus the method appears valid in at least one case. Six samples from the Lake Lahontan basin have a U$^{234}$/U$^{238}$ ratio of about 1.5, and six from Lake Bonneville have values of about 2.0. This anomaly should be detectable in samples less than 1.5 million years old. Although the available data on these two glacial lake basins suggest some variations in the ratio with different lake levels owing to changing drainage patterns, the system does not appear complicated. It appears therefore that the anomalous $A^{U^{234}}/A^{U^{238}}$ ratios in integrating basins such as the ocean, and playa lakes, provide a very promising geologic dating method for the period from 100,000 years to 1,000,000 years in both continental and marine systems. (auth)

**4719** FRENCHMAN FLAT QUADRANGLE, NEVADA, 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4720** CANE SPRING QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4721** CAMP DESERT ROCK QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4722** MINE MOUNTAIN QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4723** STRIPED HILLS QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS)

**4724** SCRUGHAM PEAK QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4725** SPECTER RANGE NW QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4726** LATHROP WELLS QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4727** YUCCA FLAT QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4728** MERCURY QUADRANGLE, NEVADA, 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4729** JACKASS FLATS QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4730** BUCKBOARD MESA QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4731** SKULL MOUNTAIN QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4732** AMMONIA TANKS QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4733** YUCCA LAKE QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4734** JANGLE RIDGE QUADRANGLE, NEVADA, 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4735** PAIUTE RIDGE QUADRANGLE, NEVADA, 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4736** PLUTONIUM VALLEY QUADRANGLE, NEVADA, 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4737** TIPPIPAH SPRING QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4738** TIMBER MOUNTAIN QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4739** OAK SPRING QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4740** RAINIER MESA QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

**4741** TOPOPAH SPRING NW QUADRANGLE, NEVADA, NYE CO., 7.5 MINUTE SERIES (TOPOGRAPHIC). (Geological Survey, Washington, D. C.). 1961. (USGS).

# HEALTH AND SAFETY

*Refer also to abstract 5584.*

**4742** (ORNL-TM-349) A SAFETY REVIEW OF THE OAK RIDGE CRITICAL EXPERIMENTS FACILITY. (Oak Ridge National Lab., Tenn.). Dec. 10, 1962. Contract [W-7405-eng-26]. 54p.

The Critical Experiments Facility located in the Y-12 Area of Oak Ridge is described with particular reference to the safety features of both the laboratory itself and the procedures established for the experiments constituting the specialized use for which the laboratory was constructed. Comparison of these experiments to others in which accident potentialities have been hypothesized sets an estimated $10^{18}$ fissions as the upper limit to the energy release to be reasonably expected as the result of the malfunction of personnel or equipment. Experimental data show the shielding incorporated in the building will adequately protect personnel from the direct radiation arising from an accident of this magnitude occurring during operations. The absence of a significant inventory of fission products in experimental materials and a simple consideration of the air-borne behavior of those produced by $10^{18}$ fissions show that hazards to non-facility personnel are highly unlikely. It is concluded that the greatest potential danger to personnel is in the course of preparing fissile materials for experiments and in their storage and transport. As in many like instances, reliance for safety must be placed on the knowledge of and caution by the individuals themselves. (R.J.S.)

**4743** (ORNL-TM-435) SMEAR TECHNIQUES FOR SURFACE MONITORING FOR RADIOACTIVE MATERIALS. E. L. Sharp and W. P. Ellis (Oak Ridge National Lab., Tenn.). Dec. 17, 1962. Contract [W-7405-eng-26]. 6p.

While it has been recognized that the smear is probably the best device for detecting low level transferable radioactivity on surfaces, there are numerous variations which involve such considerations as the type of surface smeared, dry smear vs wet smear, total area smeared, solubility of the isotope or its adherence properties, and the efficiency of the counting equipment. A few field observations have been made of some of these variables. The effects of these variables on data obtained by smear sampling have been observed in a number of field tests reported. (auth)

**4744** (TID-7027) RADIATION SAFETY AND CONTROL MANUAL. (Oak Ridge National Lab., Tenn.). June 1, 1961. Contract [W-7405-eng-26].

Information is presented to provide personnel working in the presence of radiation with an understanding of hazards and related safe practices. Topics covered include types and sources of radiation, units of measurement, permissible exposures, exposure controls, chemical and other hazards, safe practices, and emergency procedures. (R.J.S.)

**4745** (Y-KB-22) TESTS OF A PROPOSED URANIUM CONTAINER. J. D. McLendon (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Nov. 14, 1962. Contract W-7405-eng-26. 27p.

A simple, relatively cheap shipping container, available from many potential suppliers, has been designed and tested for impact and fire resistance. Although tests have been limited, results meet, or exceed, specifications of proposed standards. In view of favorable fire and impact resistance, and considering mechanical and geometric design, it is concluded that nuclear safety of enriched uranium shipments in these containers would be at least as good as that experienced with Y-12 birdcages. The container currently meets Class II, IAEA requirements. With some modifications it is conceivable that Class I specifications can be met. (auth)

**4746** AIRBORNE RADIOACTIVITY DUE TO NUCLEAR WEAPONS TESTS. P. F. Gustafson, S. S. Brar, and M. A. Kerrigan (Argonne National Lab., Ill.). J. Geophys. Res., 67: 4641-51(Nov. 1962).

Samples of surface air collected at Argonne National Laboratory since early 1952 have been analyzed for specific fission products by NaI scintillation spectrometry. The $W^{181}$ and $Rh^{102}$ produced in the Hardtack series (1958) have been used to assign nuclear debris to the low- and high-altitude phases of this series, respectively. Activity ratios between appropriate radionuclides have been used to determine the portion of total debris arising from the Soviet October 1958 series. The differences in mean stratospheric residence time as a function of latitude and altitude of injection, as deduced from these data, are discussed in detail. (auth)

**4747** INVESTIGATION ON RADIATION HYGIENE IN URANIUM MINES. T. Inoue, M. Kagami, Y. Yamada, T. Gyoda, and K. Suzuki (Musashi Kogyo Daigaku, Tokyo). J. Ind. Med. (Japan), 2: 808(1960).

Short-life breakdown products of radon and radium C′ in air, dust, and $\beta$ and $\gamma$ radiations in dust were examined twice in some pits of the uranium mines in Ningyo and Nakatusugawa. The radiation was at safe levels. However, it will be necessary in the near future to organize radiation protection and control with a portable dosimeter. (Abstr. Japan Med., 2: No. 11, Oct. 1962)

**4748** AN INSTALLATION TO AVOID DIRECT RADIATION HAZARDS IN X-RAY ANALYSIS. W. Hughes (College of Science and Tech., Manchester, Eng.). J. Sci. Instr., 39: 564-5(Nov. 1962).

A system which embodies recommendations made by the ICRP for greater protection against accidental exposure to radiation in installations used for x-ray analysis was developed and put into operation. It is based on the principle that, unless the x-ray tube ports are either closed or have a goniometer in position in the x-ray beam, x rays cannot be produced. (auth)

**4749** DOSIMETRIC CHARACTERISTICS OF ELECTRON SOURCES. V. A. Petrov (Central Scientific-Research Inst. of Medical Radiology, Ministry of Public Health, USSR). Med. Radiol., 7: No. 7, 82-8(July 1962). (In Russian)

An analysis is made of characteristics of various sources and performance of various foil materials used for uniform electron scattering. Diagrams and graphs are included that show dose absorption and distribution along the electron beam axis at 10, 20, and 30 Mev. The effects of materials and the field expansion on the depth dose are discussed. (R.V.J.)

**4750** NATURE OF NUCLEAR DEBRIS IN SEA-WATER. E. C. Freiling and N. E. Ballou (Naval Radiological Defense Lab., San Francisco). Nature, 195: 1283-7 (Sept. 29, 1962).

Alteration of radionuclide composition due to contact with radioactively inert surroundings is referred to as secondary fractionation of nuclear debris. Secondary fractionation in nuclear detonations occurring in the presence of sea water is discussed. Results are summarized from studies on the distribution of detonation product radionuclides between soluble, particulate, and colloidal states. The nature of radioactive contaminants of sea water are examined for surface, underwater, and lagoon bursts. Data are tabulated on the physical states, particle size, activity, and composition of representative fission product elements following vaporization under sea water. The pertinence of the information to questions of the biological fate, contamination, and decontamination characteristics of the radionuclides is discussed. (C.H.)

**4751** SBORNIK VAZHNEISHIKH OFITSIAL'NYKH MATERIALOV PO VOPROSAM GIGIENY TRUDA I PROIZVODSTVENNOI SANITARII. (Compilation of the Most Important Official Data on the Problems of Labor Hygiene and Industrial Sanitation. Issue 2). L. V. Yanina, ed. Moscow, Medgiz, 1962. 220p.

Thirteen papers are included on the rules of labor hygiene and industrial sanitation. The papers deal with industrial noises, vibrations, and handling and transportation of radioactive materials as well as detection, prophylaxis, and diagnosis of chronical radiation injuries. Separate abstracts have been prepared for three papers. (R.V.J.)

**4752** SANITATION RULES IN HANDLING RADIOACTIVE MATERIALS AND IONIZING RADIATION SOURCES. p.79-143 of "Sbornik Vazhneishikh Ofitsial'nykh Materialov po Voprosam Gigieny Truda i Proizvodstvennoi Sanitarii." Moscow, Medgiz, 1962.

Sanitation rules and standards are given for all laboratories and establishments handling or transporting radioactive materials. The regulations cover the general conditions and location of laboratories and installations, storage and transportation rules, dosimetric devices, ventilation, heating, plumbing, emergency measures, waste disposal, and personal hygiene and sanitation. Permissible doses for various radioisotopes and symptoms of radiation injuries are enumerated. Invoices and official forms are included. (R.V.J.)

**4753** TRANSPORTATION RULES FOR RADIOACTIVE MATERIALS. p.144-74 of "Sbornik Vazhneishikh Ofitsial'nykh Materialov po Voprosam Gigieny Truda i Proizvodstvennoi Sanitarii." Moscow, Medgiz, 1962.

Rules and regulations are given for packing and transporting radioactive materials. The classification of materials, containers, loading, and standards for various means of transportation are described. Permissible contamination and safety and warning signs are discussed. (R.V.J.)

**4754** INSTRUCTIONS AND METHODS IN PROPHYLAXIS, DIAGNOSIS AND TREATMENT OF CHRONIC RADIATION SICKNESS. p.192-220 of "Sbornik Vazhneishikh Ofitsial'nykh Materialov po Voprosam Gigieny Truda i Proizvodstvennoi Sanitarii." Moscow, Medgiz, 1962.

A review is given of symptoms of radiation injuries and of the effects of chronic radiation sickness in humans. Diagnosis, differential diagnosis, and therapy are discussed, as well as the health standards of personnel. (R.V.J.)

**4755** IMPROVEMENTS IN OR RELATING TO POWER PLANT. Stefan George Bauer (to Rolls-Royce Ltd.). British Patent 909,193. Oct. 31, 1962.

A nuclear power plant is described which has the steam-handling components distributed among a number of closed compartments. In the event of failure and pressure rise in a compartment, steam, and gas will pass through the condenser where the steam will be converted to water before passing to other compartments. (R.J.S.)

**4756** A STORAGE AND SHIPPING CASK FOR A HEAT EVOLVING RADIATION SOURCE. Donald Wheaton Montgomery (to Babcock and Wilcox Co.). British Patent 909,692. Oct. 31, 1962.

A storage and shipping cask for a heat-evolving radiation source is described. The cask consists of a pressure vessel within which the radiation source is positioned, radiation shielding associated with the pressure vessel, and a heat exchanger to remove heat generated within the pressure vessel. (R.J.S.)

# INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

*Refer also to abstract 5064.*

**4757** LUMINESCENT METHOD FOR THE REPRODUCTION OF THE DISTRIBUTION OF $\beta$ ACTIVE SUBSTANCES ON SURFACES. W. Herrmann, G. Hartmann, and K. Freyer (Institut für Angewandte Radioaktivität, Leipzig). Isotopen Tech., 2: 230-5(Aug. 1962). (In German)

A new luminescent method for the reproduction of the surface distribution of $\beta$-active substances is described, and compared with the pinhole camera method. (tr-auth)

**4758** INDUSTRIAL APPLICATION OF LARGE RADIATION SOURCES. Jósef Domanus. Przemysl Chem., 41: 114-17(Mar. 1962). (In Polish)

A review is presented of the problems raised in "Large Radiation Sources in Industry, Proceedings of a Conference on the Application of Large Radiation Sources in Industry, and Especially to Chemical Processes", organized by the International Atomic Energy Agency, Warsaw, September 8 to 12, 1959; Wien, 1960. A total of 62 references listed in the proceedings are grouped into nine divisions and the general conclusions of each reference are presented. The nine groupings are: large radiation sources and methods of using them; arrangements for the use of $Co^{60}$ and other sources; determining the energy of decomposition fragments in chemical processes; the influence of irradiation on artificial products and elastomers; polymerization and bonding induced by irradiation; ionizing radiation and chemical reactions; various applications of irradiation; application of radiation to food preservation; and economy of radiological processes. Three review articles written since the time of the conference are also discussed. Finally, the IAEA program of source normalization is briefly discussed. (TTT)

**4759** PRODUCTION OF SHORT-LIVED RADIONUCLIDES AT THE HAHN MEITNER INSTITUTE IN WEST BERLIN. F. Felix, D. Pirrwitz, and E. v. Szabo de Bucs (Hahn Meitner Institut für Kernforschung, Berlin). IAEA Preprint SM-32/9. 9p. (In English)

To be published in Proceedings of the IAEA Seminar on the Practical Applications of Short-Lived Radioisotopes Produced in Small Research Reactors, Vienna, November 5-9, 1962.

Since 1960 the Hahn Meitner Institute for Nuclear Research produces short-lived radionuclides for medical and scientific purposes in the West Berlin area. The production covers the nuclides commonly used in medical applications, such as $Na^{25}$, $K^{42}$, and $Au^{198}$, and some more outstanding nuclides such as $Cu^{64}$, $Zn^{69m}$, and $F^{18}$. $Na^{24}$ and $K^{42}$ are produced by neutron irradiation of the chlorides and distributed after calibration as solid material. $Au^{198}$ is irradiated in metallic form, suitable for implanting in cancer therapy. $F^{18}$ is produced by the reaction $O^{16}(t,n)$ and irradiation of $LiNO_3$. The separation of $F^{18}$ by ion exchange showed better results than usually given in the literature. For the production of $Cu^{64}$ and $Zn^{69m}$ special electrolytic methods have been developed to extract the radionuclides produced by a Szilard-Chalmers reaction on the phthalocyanines. Both nuclides have found application in medical diagnostics. Details are given about irradiation facilities and techniques, the production methods and apparatus, the essay and calibration of the produced radionuclides, and the production capacity. (auth)

**4760** RECENT DEVELOPMENTS IN THE STERILISATION OF SURGICAL MATERIALS. REPORT OF A SYMPOSIUM ORGANISED BY THE DEPARTMENT OF PHARMACEUTICAL SCIENCES OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN AND SMITH AND NEPHEW RESEARCH LIMITED AT THE SCHOOL OF PHARMACY, UNIVERSITY OF LONDON, APRIL 11-13, 1961. London, Pharmaceutical Press, 1961. 242p.

Eighteen papers are included; abstracts were prepared for 5. The 13 papers not abstracted in NSA include information on gaseous methods of sterilization, hospital organization in relation to the sterilization of surgical materials, and sterility tests. (P.C.H.)

**4761** APPLICATION OF RADIATION STERILISATION TO SURGICAL MATERIALS. D. B. Powell. p.9-16 of "Recent Developments in the Sterilisation of Surgical Materials." London, Pharmaceutical Press, 1961.

A review is given on the radiosterilization of surgical materials. The two types of radiation that have a practical use for sterilization are electron and gamma. Special attention is given to gamma radiation. The organism B. pumilus is recommended for checking radiosterilization. Discussion is also given on the dose required to give a high inactivation factor for B. pumilus so that a comparison can be made with the standards achieved by heat. Types of materials that can be radiosterilized are also mentioned. (P.C.H.)

**4762** HIGH ENERGY ELECTRONS FOR THE STERILISATION OF SURGICAL MATERIALS. John G. Trump. p.16-28 of "Recent Developments in the Sterilisation of Surgical Materials." London, Pharmaceutical Press, 1961.

The comparative suitability of high energy electrons for general sterilization application is considered in detail, and the physical factors involved in their use are reviewed. Criteria for evaluating the usefulness for sterilization of the several forms of ionizing energy are also given. (P.C.H.)

**4763** STERILISATION OF ADHESIVE DRESSING. James Dow. p.29-31 of "Recent Developments in the Sterilisation of Surgical Materials." London, Pharmaceutical Press, 1961.

Two types of radiation sources were used for the high-energy radiosterilization of adhesive first-aid dressings: the Van de Graaff generator producing electrons with energies of 2 Mev and a nominal power rating of 400 watts; and a radioactive source, for example $Co^{60}$, producing 1.3-Mev gamma rays, the dose being accumulated over a period of several hours. Over a number of months, contamination of the treated dressings was found to be 2.4%, which included an experimental testing error of about 2%. The economics of radiosterilization of dressings is also discussed. (P.C.H.)

**4764** STERILISATION OF DISPOSABLE HYPODERMIC SYRINGES. C. L. F. Hunter. p.32-3 of "Recent Developments in the Sterilisation of Surgical Materials." London, Pharmaceutical Press, 1961.

A simple sterility testing procedure was developed which involves the use of contaminated filter-paper test strips implanted in test syringes. The effectiveness of gamma sterilization was judged from the sterility test results obtained. So far no syringe has been rejected due to faulty sterilization; all tests confirmed sterility. (P.C.H.)

**4765** DESIGN AND PRODUCTION OF IRRADIATION PLANTS. L. G. Burnard. p.34-45 of "Recent Developments in the Sterilisation of Surgical Materials." London, Pharmaceutical Press, 1961.

The design and production of irradiation facilities using Co$^{60}$ for commercial sterilization is discussed. Consideration is given to a monorail system capable of accommodating source strengths of 30 to 100 kC. Discussion is given on reliability, safety, economy, source design, package circulation system, radiological protection of personnel, efficiency, and operational factors. (P.C.H.)

**4766** THE EFFECTS OF HIGH VOLTAGE CATHODE RAY IONIZING RADIATION ON SOME OF THE PHYSICAL AND CHEMICAL PROPERTIES OF WHEAT FLOUR PROTEIN. Elsie Beth Alsup. Thesis, East Lansing, Mich., Michigan State Univ., 1959. 121p.

The effect of irradiation on some of the physical and chemical properties of wheat flour protein was determined. A study of the baking quality and palatability of an irradiated flour product, yields of crude gluten from irradiated flour, and electrophoretic analyses of some of the protein fractions of irradiated flour were studied. Triangle taste tests indicated that 50000 rep was the dosage level at which the irradiation treatment of flour could be detected in baking powder biscuits. Taste panel scores for color, odor, and baking characteristics of biscuits made with flour treated with 100000 rep or less of ionizing radiation, however, were not significantly different from the scores for the control biscuits. An off-odor and darkening in color of the biscuits were readily apparent at a dosage of 500000 rep. The weight of crude gluten extracted from flour was greater from flour exposed to dosages of 1000000 rep or less than from the control flour, but no differences were found in the volumes of the baked balls of crude gluten. This indicates a greater water retention with the irradiated flour. Very small yields of crude gluten at dosages of 3000000 rep or more indicated that definite changes had occurred in the protein structure. Electrophoretic analyses by the moving boundary method were performed on acetic acid extracts of whole flour in a citric acid–disodium phosphate buffer pH 2.2, ionic strength 0.024. Electrophoretic patterns obtained from the non-irradiated flour indicated that there were at least six separate protein components present, including one which was fast-moving and high in relative concentration, one which was slow-moving and medium high in relative concentration, and four relatively small components. Irradiation of the flour with 300000 rep produced no apparent changes in the electrophoretic patterns obtained, but at 1000000 rep or more, the relative concentrations of the two largest components were changed (the slow-moving one becoming larger and the faster-moving one smaller with each increase in dosage). Also with increased radiation dosages, the peaks of the smaller components became less distinct until only the two main peaks were distinguishable at 10000000 rep. (Dissertation Abstr., 23: No. 4, 1962)

**4767** INFLUENCE OF INTRAMUSCULAR FAT LEVEL ON ORGANOLEPTIC, PHYSICAL, AND CHEMICAL CHARACTERISTICS OF IRRADIATED PORK MUSCLE. Leo Anthony Whitehair. Thesis, Madison, Wisc., Univ. of Wisconsin, 1962. 287p.

A study was conducted to evaluate the influence of marbling on certain organoleptic, physical, and chemical characteristics of precooked and irradiated pork loin muscle (*longissimus dorsi*). The study consisted of two separate phases. Loins utilized in Phase I were selected by visual appraisal and categorized into three distinct marbling level scores. A high temperature, short time blanching treatment was used for proteolytic enzyme inactivation. Phase II loins were selected and classified into three marbling levels by both visual appraisal and ether extraction analysis of total fat. A low temperature, long time heat treatment was used for enzyme inactivation. Samples were packed under vacuum in rigid containers and irradiated at a dosage level of 4.5 megarads gamma radiation. Non-irradiated samples were stored at −65°F. Irradiated and control samples were evaluated at periodic intervals by a panel. Physical and chemical analyses were made initially on samples representing each treatment and subsequently at the termination of each storage period. Organoleptic results indicated that degree of marbling did not influence preference ratings of plain radiosterilized *longissimus dorsi* muscle (pork). However, irradiated *longissimus dorsi* (pork) sandwich items with lower marbling scores were consistently preferred over highly marbled, irradiated sandwich items. Non-irradiated *longissimus dorsi* samples were preferred to irradiated *longissimus dorsi* samples in all tests. The short term-high temperature method of blanching used in Phase I resulted in products of slightly superior quality to those of Phase II, which possessed softer, slightly drier texture characteristics. The practical storage life of irradiated samples under the conditions was approximately 150 days. Hunter color values were increased by radiation treatment. Irradiated *longissimus dorsi* samples developed a characteristic pink-red color. Mechanical tenderness values in both irradiated and non-irradiated samples were lowered significantly by higher levels of marbling. Expressible moisture values of irradiated samples were lower than those of control samples. The values increased with advancing storage time. Iodine numbers of lower marbling scores (both irradiated and non-irradiated samples) exceeded those of highly marbled samples. T.B.A. number values were lower in irradiated samples of Phase I. The values were increased with respect to increased levels of marbling in Phase II. Values increased steadily with advancing storage time in both phases. pH values were elevated by irradiation treatment, marbling level, and storage time in Phase I. The differences were not observed for Phase II samples. Bacteriological assays indicated that irradiated samples were commercially sterile. Extremely low numbers of *Micrococci* were found. (Dissertation Abstr., 23: No. 4)

**4768** PIPE-LINE EXPLORATION. Serge A. Scherbatskoy. U. S. Patent 3,060,315. Oct. 23, 1962.

Two radiometric methods are outlined for locating leaks in buried oil pipelines. In one method, a probe instrument comprising a neutron source and a gamma ray detector is moved along the pipe interior, and an accumulation of oil in the soil adjacent a pipe leak is detected by an increase in the detector output. In the second method, a radioactive tracer is injected in the flowing oil, and the resulting radioactive accumulation from a leak is detected by the probe. The position of the leak may be determined using radioactive capsules distributed around the pipeline or casing collars spaced around the pipeline and a magnetic flux detector in the probe. (D.L.C.)

# INSTRUMENTS AND INSTRUMENTATION

## General and Miscellaneous

**4769** (IS-432) SIMPLE HIGH-VOLTAGE TRAPEZOIDAL PULSE GENERATOR. Luigi Gonella (Ames Lab., Ames, Iowa). [Mar. 7, 1962]. Contract [W-7405-eng-82]. 7p.

A description is given of a circuit used to produce negative voltage pulses up to 60 kilovolts with a portion rising with constant slope up to 10 kilovolts per microsecond. (auth)

**4770** (MATT-95) NONLINEAR COUPLED OSCILLATORS. I. PERTURBATION THEORY; ERGODIC PROBLEM. E. Atlee Jackson (Princeton Univ., N. J. Plasma Physics Lab.). Aug. 1962. Contract AT(30-1)-1238. 21p.

A study was made of some of the problems in determining the long time behavior of a system of coupled oscillators. Standard perturbation methods were examined in the light of certain classic results due to Poincaré and Whittaker concerning the construction of constants of the motion in powers of the coupling constants, λ. These considerations led to the development of perturbation methods which are not ordered in powers of λ. The ergodic properties of these systems were also studied, with an emphasis on the difficulties in establishing theoretical criteria in this field. (auth)

**4771** (NP-12236) A SLIT FUNCTION CORRECTION AND AN APPLICATION TO THE STUDY OF THE ABSORPTION LINES IN THE $H_2O$ PURE ROTATION SPECTRUM. Progress Report. Hajime Sakai (Johns Hopkins Univ., Baltimore. Lab of Astrophysics and Physical Meteorology). Oct. 15, 1962. Contract Nonr 248(58). 113p.

The slit function correction of the spectrometer was treated with considerable accuracy. In its physical basis and applicability, it was found to be very closely related to the classical concept of optical resolving power. The conventional slit function correction widely employed in practice was evaluated, and its ability to yield proper line parameters was determined from the general theory. The slit function for the spectrometer used was experimentally determined and compared with the theoretically established formula. After application of this slit function correction, the shape of $H_2O$ absorption lines in the 600 $cm^{-1}$ region was found to approximate the Lorentzian line shape reasonably well in the range where the measurements were not obscured by the noise level. The strengths of 14 $H_2O$ lines in the 500 to 600 $cm^{-1}$ region were determined under the assumption of Lorentzian line shape, and centrifugal distortion was indicated as responsible for the difference in observed and calculated rigid rotator line strengths. Line widths in the 450 to 600 $cm^{-1}$ region were broadened under the collision interactions $H_2O$-$H_2O$, $H_2O$-air, $H_2O$-$N_2$, $H_2O$-$CO_2$, and $H_2O$-He, and were measured and compared with theoretically computed widths. (auth)

**4772** (RFP-253) RADIOACTIVE FILTER BANK FIRE DETECTION SYSTEMS. R. W. Walker (Dow Chemical Co. Rocky Flats Plant, Denver). Dec. 27, 1961. Contract AT(29-1)-1106. 14p.

The detection of radioactive air filter fires is discussed. Criteria requirements for a suitable fire detection system were established. The applicability of aircraft-type fire detection systems for this use was evaluated. The operation of a discrete eutectic salt type continuous fire detection tubing system is outlined. (M.C.G.)

**4773** (TID-14796) A SPARK-DISCHARGE LIGHT SOURCE FOR TIME-RESOLVED ABSORPTION SPECTROSCOPY. H. Milton Peek (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 52p. (LADC-5223)

Determinations of spectral steradiancy, time-resolved spectrograms, and smear camera photographs were made for a quartz-envelope electronic flash lamp filled with various mixtures of Xe, Ar, Ne, $N_2$, and $H_2$. Two types of firing circuits were used. One produced flashes of about 2 μsec duration, and the other produced flashes whose duration could be changed from a minimum of about 3 μsec to a maximum of about 250 μsec. For most lamps the spectral steradiancy is about 10 $w/cm^2/sr/Å$. The dependence of spectral steradiancy on time is a function of the gas composition, initial pressure, and initial voltage across the lamp. So long as appreciable current flows in the lamp, the spectrum is a continuum in the wavelength range 1950 to 9000Å, with a few absorption lines due to Si. Smear photographs taken with a time resolution as short as $5 \times 10^{-9}$ sec show luminous oscillations which have a period of about 2 μsec and which last for 5 to 10 μsec. After this period the entire interelectrode region radiates uniformly. It is concluded that these lamps are very good light sources for high-resolution, time-resolved absorption spectroscopy. (auth)

**4774** (EURAEC-415) THERMAL CONDUCTIVITY MEASUREMENTS AT HIGH TEMPERATURES. Special Report No. 3. (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). June 1962. Work Performed under United States—Euratom Joint Research and Development Program. Contract 037-60-12 RDF. 25p. A translation.

Test pieces in the form of plates or cylinders a few millimeters in diameter are heated by electronic bombardment up to the measuring temperature. With relatively low temperatures, it is possible to calculate the thermal conductivity from the temperature gradient measured along the test-piece axis. For high temperatures, the electronic radiation power is made to vary in time, and the temperature oscillations which result on the frontal surfaces or along the axis of the test piece are recorded by pyrometer or by thermocouples. The thermal diffusivity of the material is calculated from the variation of the amplitude or difference of phase of these signals in terms of time. (R.J.S.)

**4775** (NP-tr-923) THE USE OF FLAT AND CURVED MONOCHROMATOR CRYSTALS IN NEUTRON SPECTROMETERS FOR INVESTIGATING SINGLE CRYSTALS. H. Dachs and H. Stehr. Translated by L. F. Secretan (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Z. Krist., 117: 135-45(1962). 19p.

Previously calculated formulas for the half-value width of reflections from single crystals and the counter-tube apertures used were tested. It was found that an extension of the equations allowing for a curvature of the monochromator crystal can improve the quantitative agreement with experimental results. A method for determining the constants of the apparatus is included. (J.R.D.)

**4776** A HIGH-SPEED ROTATING-MIRROR FRAMING CAMERA. W. C. Davis (Los Alamos Scientific Lab., N. Mex.). Appl. Opt., 1: 407-9(July 1962). (TID-13632; LADC-5013)

A new arrangement for a high-speed rotating-mirror framing camera using mirror strips instead of lens strips as framing stops is described. The design is especially simple when a few frames close together in time are required. A camera which takes 14 frames resolving about 150 line pairs across the frame at a rate of 10,000,000 frames per second, or 14 frames resolving 250 line pairs at a rate of 5,000,000 frames per second is also described. The effective exposure time is 80% of the time between frames, and the camera operates at effective aperture of f/20. (auth)

**4777** THE POSSIBILITIES FOR GAS DENSITY GAUGING BY SINGLE SCATTERING OF ELECTRONS. H. R. Falckenberg and B. W. Schumacher (Ontario Research Foundation, Toronto). Can. J. Phys., 40: 1521-7(Nov. 1962).

The sensitivity of a gage using single scattering of electrons is calculated, as well as the pressure range where it can usefully be employed. For a primary electron beam of between 30 and 100 kev and 100 $\mu$a, the calculated pressure range is found to cover about 12 orders of magnitude with a low limit of approximately $10^{-13}$ torr dependent on the geometry of the gage. For beta rays, the useful range is less and the lower limit is likely to be near $10^{-6}$ torr. The upper limit of the gage will be more than one atmosphere if multiple scattering and attenuation are also utilized, no change in gage structure being necessary. If applied practically as an altimeter in the free atmosphere, the gage with beta source would give a continuous record of density up to about 100 miles. (auth)

**4778** A CONTRIBUTION TO THE THEORY OF X-RAY MONOCHROMATORS. J. Čermák (Inst. of Solid State Physics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 12: 588-601(1962). (In English)

The characteristic function is introduced, describing completely the monochromating effect of monochromating units. Expressions for this function are presented for monochromating units frequently used. An example of computation for Johansson's unit shows the conditions in a special case. The curves indicating the shift of the wavelength centroid of monochromated radiation for crystals of different perfection allow conclusions to be drawn about the influence of the alignment of the crystal on precision measurements of lattice constants. The experiments verify the suggested model. The computations for a given experimental arrangement permit a simple determination of the effective breadth of the reflection curve, if a distance of two suitably chosen diffraction lines of a polycrystalline specimen is measured. Finally, it was found experimentally that a small elastic bending does not essentially alter the reflection curve of highly elastic and imperfect crystals unless macroscopic distortions are present. (auth)

**4779** CHOICE OF PARAMETERS OF AN X-RAY MONOCHROMATING UNIT. J. Čermák (Inst. of Solid State Physics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 12: 602-13(1962). (In English)

In recent papers a way of computing the monochromated wavelength distribution in some current experimental arrangements was presented. In this paper an application is shown for the Johansson monochromating unit. The conditions are indicated for attaining the desired breadth of the monochromated interval and for its maximum intensity. The analysis implies that it is not advantageous to use very narrow foci and that the crystals should be neither very perfect nor very imperfect. The optimum conditions must be found in each case separately. (auth)

**4780** CLARIFICATION OF SOME BASIC TERMS IN THE INSTRUMENTATION FIELD. A. B. Shaevich. Izmeritel. Tekhn., No. 10, 1-3(Oct. 1962). (In Russian)

In order to avoid misunderstanding, expressions used with reference to numerical values must be clearly defined, indicating if possible the limits of error. On the basis of Russian and foreign literature some basic terms of special interest for the measuring technology are defined as follows: Precision is the degree of reproducibility of independent measurements of the same magnitude under the specified conditions; some specialized fields, such as analytical chemistry or spectral analysis, use the term reproducibility of repeatability in the same sense. Accuracy indicates the nearness of theoretical or experimental data to the exact or true value, thus indicating the absence of error. The given Russian terms are recommended for translating these terms in articles in the metrology, mathematical statistics, automation, information theory, and related fields in order to transmit the true meaning of the authors. (TTT)

**4781** A VARIABLE COMPOSITION, HIGH FIELD SUPERCONDUCTING SOLENOID. H. Riemersma, J. K. Hulm, A. J. Venturino, and B. S. Chandrasekhar (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys., 33: 3499-3504(Dec. 1962).

The critical current in short samples at 21,000 G and 4.2°K decreases with increasing zirconium content for the compositions investigated, namely, Nb + 25% Zr, Nb + 33% Zr, and Nb + 50% Zr. The critical magnetic field in these alloys rises with increasing zirconium concentration in the same range of compositions. A solenoid is thus built that is composed of several concentric sections with the lowest composition (25% Zr) on the outside and the highest composition (50% Zr) on the inside. Experiments with this coil are discussed. (auth)

**4782** A 100 KV SWITCH FOR RAPID DISCHARGE OF HIGH ENERGY CAPACITATORS. A. E. Bishop, G. D. Edmonds, and J. Sheffield (United Kingdom Atomic Energy Authority, Abingdon, Berks, Eng.). J. Sci. Instr., 39: 566-8(Nov. 1962).

A pressurized, low inductance switch (250 nh) operating between 40 and 100 kv and up to 30 ka for discharging low inductance capacitors is described. The breakdown time of the switch is about 60 nsec, with a jitter of less than 20 nsec. (auth)

**4783** ELECTRONIC CONTROL OF THE BOILING-DOWN PROCEDURE WITH AUTOMATIC SAMPLE CHANGER. K. Zander (Hahn-Meitner-Institut für Kernforschung, Berlin). Kerntechnik, 4: 444-5(Oct. 1962). (In German)

Applications of a two-point regulating system for keeping the fluid level of radioactive solutions in counting vessels constant during the boiling-down procedure are presented. An automatic sample changer for 12 pipettes of various strengths, which is regulated by the electronic part of the system, is also described. (P.C.H.)

**4784** A METHOD FOR THE DESIGN OF AXIALLY SYMMETRIC MAGNETIC FIELDS FOR IMAGE TUBE SYSTEMS. B. Zacharov (CERN, Geneva). Nucl. Instr. Methods, 17: 132-6(Oct. 1962). (In English)

A numerical method is described for computing the current density distribution in a multisection coil, to reproduce a given magnetic field possessing axial symmetry. Examples are given of calculations for homogeneous and inhomogeneous fields of the order $10^{-2} - 10^{-1}$ Wb/m$^2$. (auth)

**4785** A TWO-CHANNEL REGULATING DELAY SYSTEM. TYPE DRO-2. Stanisław Kolber (Inst. of Nuclear Physics, Electronics Division, PAN, Krakow). Nukleonika, 7: 431-4(1962). (In Polish)

The regulating circuit operates an ultra-fast shutter of a camera used in plasma physics research. The circuit synchronizes the moment of opening of the shutter with the physical process to be photographed and determines the exposure time of the film. In a manual, single-shot mode of operation, the circuit provides a series of four delayed pulses: the first activates the registration circuit, the second initiates the single-shot physical process, the third opens the shutter, and the fourth closes the shutter. The delay time between these events can be varied by selector switches provided as part of the circuitry. The delays are generated by four univibrators connected in tandem. A separate pulse shaper and driver tube pick off the trailing edge of each univibrator pulse and provide the proper pulse shape for performing the necessary function. Vacuum tube triodes are used throughout the circuit. The delay times range from 0.6 to 300 microseconds. (TTT)

**4786** NEW METHOD OF MEASURING ELECTRICAL CONDUCTIVITY WITH A MAGNETIC PROBE. K. Thom and J. Norwood, Jr. (National Aeronautics and Space Administration, Hampton, Va.). Phys. Fluids, 5: 1484-5 (Nov. 1962).

A new method is described for measuring the electric conductivity of a moving conductor with a magnetic probe. When a conducting body passes through a magnetic field at rest, the lines of force are displaced until an equilibrium of the induction drag forces and the magnetic stresses of the distorted field is established. A magnetic-probe coil placed in the area of the magnetic field monitors the rate of change of the magnetic flux density $\partial B/\partial t$. When the lines of force approach the state equilibrium, $\partial B/\partial t$ approaches zero. By measuring the decay time of $\partial B/\partial t$ as the decay time of the voltage signal displayed on an oscilloscope, the conductivity of the passing conductor can be determined. (L.T.W.)

**4787** REVERSED-BIASED P-N JUNCTIONS IN ELECTRON TUBES. F. A. White and J. C. Sheffield (Knolls Atomic Power Lab., Schenectady, N. Y.). Proc. I.R.E. (Inst. Radio Engrs.), 50: 1523-4(June 1962). (TID-15345; KAPL-P-2198)

A suggested new class of electronic components, "semitron," would combine electron tubes and semiconductors. The possible applications and limitations of semitron tubes containing reversed-biased junctions as elements are briefly discussed. (R.J.S.)

**4788** LOW IMPEDANCE TRANSMISSION SYSTEM FOR DRIVING CRYOGENIC CIRCUITS. David J. Dumin (International Business Machines Corp., Yorktown Heights, N. Y.). Rev. Sci. Instr., 33: 715-20(July 1962).

The possible advantages and disadvantages of driving cryotron circuits with a low-impedance transmission system instead of a high-impedance system are discussed. It is shown that although losses are higher in a low-impedance cable, a reduction in the signal coupled between cables in a cryotron system is possible when low-impedance cable is used. Two low-impedance generators are described. These generators have a maximum frequency between 500 kc and 1 Mc. The rise time is less than 2 nsec and can be improved when the generators are packaged in strip line module form. Pulse amplitude is about 1.5 amp. Pulse width is variable by use of a delay cable. (auth)

**4789** MANUFACTURE OF SOLID ORGANIC STANDARD LIGHT SOURCES OF LOW INTENSITY. T. J. Pepin and E. P. Ney (Univ. of Minnesota, Minneapolis). Rev. Sci. Instr., 33: 724-5(July 1962).

A manufacturing technique is described by which low-intensity ($\sim 5 \times 10^{-6}$ ergs/cm$^2$ sec sr in units of astronomical photographic intensities at $\lambda = 4300$ Å and $\Delta\lambda = 1290$ Å) standard light sources can be produced by the polymerization of an organic plastic scintillator containing a low-energy $\beta$ emitter. (auth)

**4790** LIQUID LEVEL HELIUM THERMOMETER. P. J. Bendt (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 33: 759-61(July 1962).

A closed thermometer is described that contains a tube of He$^3$ or He$^4$ in liquid-vapor equilibrium. The temperature is calculated by measuring the volume of liquid originally inserted into the thermometer, and the change in the liquid level in the tube as the temperature is changed from a reference temperature to the unknown temperature. The temperature-vapor pressure characteristics of the liquid used must be taken into account in the calculation of the temperature. The behavior of this type of thermometer from 0.8 to 4.2°K is described. (T.F.H.)

**4791** ATTENUATORS FOR HIGH FREQUENCY PULSES. H. L. Stadler (Ford Motor Co., Dearborn, Mich.). Rev. Sci. Instr., 33: 761(July 1962).

An asymmetric pi-type pulse attenuator is described. Calculations show that this type of attenuator should not cause degradation of pulses having frequencies less than 1.4 kMc. The attenuator is found experimentally to cause no degradation in pulses having rise times of 1.5 nsec. (T.F.H.)

**4792** CONTINUOUS CHANNEL ELECTRON MULTIPLIER. G. W. Goodrich and W. C. Wiley (Bendix Corp., Detroit). Rev. Sci. Instr., 33: 761-2(July 1962).

Glass tubes that are coated on their inside surfaces with a semiconducting metallic oxide, and that have a potential difference of 1 or 2 kv between their ends, are used as continuous-dynode electron multipliers. An electron entering one end of the tube strikes the oxide coating and releases secondary electrons, which drift down the tube before striking the tube wall again. The gain and noise characteristics of this type of electron multiplier are described. (T.F.H.)

**4793** CHARACTERISTICS OF THE ZIRCONIUM-ARC INFRARED SOURCE. George C. Turrell (Howard Univ., Washington, D. C.). Rev. Sci. Instr., 33: 771-2(July 1962).

A water-cooled Zr-arc lamp with a NaCl window is described, and its output intensity characteristics are shown in the wavelength range of 0 to 14 $\mu$. The intensity of the output of this lamp is compared with that of a conventional source that operates at a lower temperature. (T.F.H.)

**4794** ZEEMAN MODULATOR FOR NUCLEAR QUADRUPOLE RESONANCE SPECTROSCOPY. Eric D. Jones (Univ. of Washington, Seattle). Rev. Sci. Instr., 33: 775-6 (July 1962).

A transistorized generator is described that can produce square-wave alternating magnetic fields having intensities of about 100 Oe, at frequencies up to 100 cps. Typical field rise and decay times are 500 and 60 $\mu$sec, respectively (T.F.H.)

**4795** PRESSURE TRANSDUCER EVALUATION REPORT. W. R. Humphrey (General Electric Co., Cincinnati). p.191-243 of "Semiconductor and Conventional Strain Gages." Mills Dean, III, ed. New York, Academic Press, 1962.

Performance evaluation of 17 unbonded strain gage transducers was conducted to determine the suitability of these models to measure air pressures in an air cycle reactor system. The requirement was a maximum of ±2% error for 50 hours of continuous operation with an operating temperature of 150 to 250°F and a maximum vibration of 5 g. The results indicate that this type of transducer will perform satisfactorily. (D.L.C.)

**4796** ION OPTICS OF MASS SPECTROMETERS WITH VIRTUALLY ENLARGED RADIUS. Herman Abel Tasman, Thesis, Leiden, Rijksuniversiteit, 1961. 104p.

It is found that the mass dispersion of magnetic analyzing fields for mass spectrometers may be increased without increase in radius of deflection by employing inhomogeneous magnetic fields. If at the main path $-(r/B)\partial B/\partial r = n (0 \leq n < 1)$, the mass dispersion and resolution are increased essentially by the factor $1/(1-n)$. The imaging properties of this type of sector fields are derived up to the second order. The shape of the pole faces and the influence of boundary inclination and curvature are discussed. Several adjustable devices are discussed for the elimination of first and second order aberrations. Actual measurements with a pair of very carefully made conical pole faces show agreement with the calculated field shape. It is shown that the influence of the finite radial extension may be reduced by appropriate correction turns. Similar considerations apply to toroidally curved electrostatic sector fields, where the energy dispersion can be increased as compared with that in the cylindrical electrostatic field. The imaging properties are derived up to the second order along the same lines as for the inhomogeneous magnetic sector fields. The required shape of the deflecting electrodes is mentioned. For a so-called tandem arrangement of a toroidally curved electrostatic sector field followed by an inhomogeneous magnetic sector field, the imaging properties are derived up to the second order, including the trajectories outside the median plane. The conditions are presented for double focusing and for stigmatic focusing. For deflection in the same sense in these subsequent fields, numerical evaluation revealed the possibility of a new type of "pretzel"-arrangement, consisting of 300° electrostatic deflection followed by 300° magnetic deflection. In these arrangements stigmatic double focusing may be achieved in first order, together with elimination of the second order aberrations in the median plane and minimalisation of those outside the median plane. Stigmatic double focusing with subsequent deflection in the opposite sense is also possible; some numerical examples are given. In all these examples the resolution, depending on the ratio of the mass dispersion to the lateral magnification, is considerably increased as compared with similar combinations of homogeneous magnetic fields with cylindrical electrostatic fields, whereas the stigmatic focusing obtained may improve the transmission and sensitivity of the instrument. (auth)

**4797** IMPROVEMENTS IN OR RELATING TO MIXER SETTLER APPARATUS. Leonard Lowes and Maurice Charles Tanner (to United Kingdom Atomic Energy Authority). British Patent 909,485. Oct. 31, 1962.

A mixer-settler apparatus is described that is provided with electrodes to produce an electric field in that region of the settler compartments normally occupied by the emulsion band. (R.J.S.)

**4798** IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF METAL STRIP ELECTRIC CAPACITORS HAVING IRRADIATED DIELECTRIC MATERIAL. Alan Richard Gilbert (to Standard Telephones and Cables Ltd.). British Patent 910,245. Nov. 14, 1962.

A process is described for feeding through a zone of high-energy radiation a metal strip, coated on both faces with a layer of polymerized dielectric material. Cross-linking is produced between the molecules of the dielectric material. (R.J.S.)

**4799** DEVICE FOR X-RAY SPECTROCHEMICAL ANALYSIS BY MEANS OF FLUORESCENT RADIATION. Shoerd Wytzes (to North American Phillips Co., Inc.). U. S. Patent 3,060,314. Oct. 23, 1962.

An x-ray spectrometer for analyzing the fluorescent radiation of an object in an x-ray beam, is designed which covers a wide range of wavelengths. The spectrometer comprises a monocrystal made up of two parts whose lattice constants are different, a gas-filled counter tube oriented in the direction of the rays deflected with the highest lattice constant, and a scintillation counter arranged in the direction of the smallest lattice constant. The monocrystal consists of two crystal plates which are mounted rotatably. (D.L.C.)

**4800** X-RAY CONE. Leonard F. Peyser (to Howdon Videx Products Corp.). U. S. Patent 3,060,316. Oct. 23, 1962.

A compact, inexpensive x-ray cone with an improved light centering mechanism is designed which is an improvement of that described in U. S. Patent 2,881,329. The cone has a pair of L-shaped aperture plates defining a rectangular aperture, an adjustable iris diaphragm, and means for moving the aperture plates in response to adjustment of the iris diaphragm. (D.L.C.)

**4801** THERMOELECTRIC SYSTEM. Milton M. Waller (to Nuclear Corp. of America). U. S. Patent 3,064,440. Nov. 20, 1962.

A system has been designed to increase the rate of heat dissipation at the reference junction of a thermoelement and to stabilize the operating temperatures of the thermoelement. These objects are attained by the use of a reservoir arranged to contain a melting material in contact with the reference electrode of the thermoelement. (R.J.S.)

**4802** IONIZATION VACUUM GAUGE. Edgar T. Pennington (to Sylvania Electric Products Inc.). U. S. Patent 3,067,346. "Application date Dec. 7, 1959."

An apparatus is described for measuring very low gas pressures, such as those within evacuated chambers, by measurement of an ionization current established within the rarefied atmosphere of the gas. The ionization gauge features an elongated cylindrical accelerating electrode, a filamentary cathode disposed within the accelerating electrode, and an ion collector also positioned within the accelerating electrode. (R.J.S.)

**4803** GASEOUS PLASMA LENS. Roger C. Jones and Girard R. Lowrey, Jr. (to Melpar, Inc.). U. S. Patent 3,067,420. "Application date Apr. 28, 1959."

Gaseous plasma lenses for radio waves that employ controlled plasma resonance to vary the distribution function of dielectric constant within quasi-Eaton or quasi-Luneberg type lenses, are described. (R.J.S.)

## Radiation Detection

**4804** (ARL-62-406) SOLID STATE CHARGED PARTICLE SILICON DETECTORS. Final Technical Report. J. W. Hallam and R. L. Williams (RCA Victor Co., Ltd., Research Labs., Montreal). Aug. 1962. Contract AF33 (616)-8373. 15p.

Research was carried out on the lithium ion drift method of making wide depletion layer solid state nuclear particle detectors. Lithium ions, drifting in the field of a reverse biased silicon diode at temperatures in the 100 to 140°C range, compensate to a high degree the original impurities of a pellet. With a suitably drifted unit, a voltage of 100 volts or less will extend with depletion layer completely across a compensated region a few millimeters deep. (auth)

**4805** (DC-60-2-80) A NEW TYPE AC IONIZATION CHAMBER. G. K. Rusch (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 5, 1960. Contract [AT(11-1)-171]. 10p.

An a-c ionization chamber capable of high sensitivity and fast response is described. It can readily be made suitable for rugged service requirements, including high temperature environments. The basic chamber design is uncomplicated. In addition, the associated circuitry is relatively simple and transistorized circuitry may be used. (R.J.S.)

**4806** (HW-SA-2191) SCINTILLATING GLASSES FOR ALPHA COUNTING. U. L. Upson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 15, 1961. Contract AT(45-1)-1350. 19p.

Two samples of scintillating glasses were tested as alpha detectors, particularly with respect to their application to the continuous monitoring of liquid process streams. Although exhibiting much lower quantum efficiencies than protected zinc sulfide alpha phosphors, they have excellent durability and chemical resistance, respond more rapidly to solution changes, and have better energy resolution and higher counting yields. Beta-gamma rejection is inferior to that of ZnS phosphors, largely owing to the greater active volumes of the glass phosphors. Since low quantum efficiency (pulse height) can be offset by using low-noise high-gain amplification, their advantages—particularly durability and fast recovery—make them superior to the inert-film-covered ZnS screens now in use. Of the two tested, the 50% silica Mg–Li–Al glass was found superior to a 96% silica glass, quantum efficiencies relative to ZnS being 7.5 and 3.1%, respectively, for ca. 0.09 in. thick specimens. Both glasses are cerium activated, but in the high-silica glass matrix the cerium exhibits $Ce^{IV}$ absorption characteristics and substantially absorbs its own scintillations. This effect is reduced by reducing the thickness of the phosphor, feasible only for alpha counting. For very thin glass plates, the high-silica glass may prove equal to the Mg–Li–Al glass. (auth)

**4807** (MITNE-8) NEUTRON DOSIMETRY, SPECTROMETRY, AND NEUTRON ACTIVATION ANALYSIS. Final Report. Theos J. Thompson, Norman C. Rasmussen, and Daniel Schwartz (Massachusetts Inst. of Tech., Cambridge). Oct. 1961. Contract AF19(604)-3461. 33p. (AD-274320; AFCRL-62-1)

A thorough investigation of the leakage spectrum from the MITR (MIT Reactor) has been carried out using the MITR fast chopper. These measurements were made for three different fuel loadings in the energy range from 0.001 ev to 10 kev. They were compared with several theoretical models and are in fairly close agreement with the heavy gas model. A semiconductor neutron spectrometer is described that will be used for high energy spectrum measurements. A triple coincidence pair spectrometer designed for high efficiency is described. Calibration results using $Na^{24}$ are reported. Operation of a 6 m bent quartz crystal spectrograph for capture gamma ray measurements is described. (auth)

**4808** (NASA-TN-D-1097) SCANNING MECHANISM FOR A SATELLITE BORNE X-RAY SPECTROMETER. Gerald L. Hempfling (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Nov. 1962. 14p.

One experiment aboard the Orbiting Solar Observatory I satellite (1962ζ) employs an x-ray spectrometer. Three distinct mechanisms were designed to perform this instrument's scanning function, i.e., moving the detector along the focal curve; the mechanism which proved most satisfactory was to be used in the satellite. The design and testing of one such mechanism is documented here. This device also maintains the detector perpendicular to the radiation beam incident from the grating, as the detector moves along the focal curve. It was later decided that there was no certain advantage in maintaining this perpendicularity of the detector. Hence, one of the simpler mechanisms lacking the incidence correction feature was selected for use in the satellite. The information should be useful in future designing of similar devices, particularly when the detector is required to remain perpendicular to the incident rays. (auth)

**4809** (NP-12248) A LIQUID SCINTILLATION SYSTEM FOR USE WITH A CHERENKOV SYSTEM TO INVESTIGATE INTERACTIONS OF HIGH ENERGY MUONS WITH HEAVY NUCLEI (thesis). Research Report No. S-1. Gary L. Buckwalter (United States Naval Academy, Annapolis, Md.). June 1961. Contracts NR 015-909 and Nonr-2249(04). 28p.

A large liquid scintillation detector was developed for use in conjunction with a Cherenkov meson telescope to investigate the interaction with small energy transfer of high-energy muons with heavy nuclei. The detector is in the form of a cubic plexiglass box and employs decalin activated with alpha-NPO and p-terphenyl as the scintillating material. The electronic equipment associated with the detector was assembled and tested. An energy spectrum for local background and cosmic radiation was determined. (auth)

**4810** (AEC-tr-5540) INCREASE OF INTENSITY IN TIME-OF-FLIGHT MEASUREMENTS BY SWEEPING THE BEAM OVER THE TARGET. F. L. Shapiro. Translated by Helen J. Chick and Lawrence Cranberg (Los Alamos Scientific Lab., N. Mex.) from Pribory i Tekhn. Eksperim., No. 1, 33-6(1957). 9p.

A method of boosting the luminosity of a neutron spectrometer for time-of-flight work by sweeping the ion beam over the target was investigated. The sweeping beam is so arranged that the neutrons produced go through a shorter path to the detector, thus making possible an increase in intensity without impairing the resolution for a narrow specified velocity range. With a fixed-duration source burst, improved resolution is obtained without loss of intensity. (J.R.D.)

**4811** A MONITOR FOR URANIUM AND PLUTONIUM IN THE AIR. AEI (Assoc. Elec. Ind.) Eng., 2: No. 6, 309-11(Nov.-Dec. 1962).

An air monitor (the AMI) was developed to exploit the properties of a silicon surface barrier detector in a health physics instrument featuring background separation, uranium-plutonium discrimination, high sensitivity, rapid response, and the ability to evaluate true biological hazard. The instrument was designed to operate over a 0 to 40°C temperature range and is suitable for main voltages of 110 to 240 v, 50/60 c/s; variations of ±20% can be accommodated. The complete apparatus consists of an air sampling unit, blower and indicator unit, and the electronic circuitry. (P.C.H.)

**4812** A DOUBLE-FOCUSING BETA SPECTROMETER FOR CONVERSION ELECTRONS FROM (n,γ) PROCESSES. THE CONVERSION ELECTRON SPECTRUM OF $Dy^{165}$–$Ho^{165}$. Till von Egidy (Technische Hochschule, Munich). Ann. Physik, 7: 221-41(1962). (In German)

For the Garching research reactor at Munich, a β spectrometer was built in order to measure the conversion electrons from (n,γ) processes. The preparation was near the reactor core. The electrons emerge through an evacuated tube in the reactor shield and are passed into the β spectrometer. This is a surface spectrometer which deflects the electrons about 90° through a partially homogeneous, partially inhomogeneous magnetic sector field with double focusing. With a preparation surface of 10 × 30 mm$^2$, a space angle of $10^{-5}$ sterad/4π, a transmission of $3 \times 10^{-6}$, and a luminosity of $3 \times 10^{-5}$ cm$^2$, a half-value width of 0.11% was obtained for the lines in the pulse fraction. Electrons between 35 kev and 10 Mev could be measured. The entire installation was first constructed outside the reactor in order to test and adjust it. The spectrometer was calibrated with a known conversion line of $Cs^{135}-Ba^{137}$ and $Au^{198}-Hg^{198}$. Then the conversion ratios of $Cs^{137}-Ba^{137}$ and $Au^{198}-Hg^{198}$ were determined. With the spectrometer constructed outside the reactor the conversion spectrum of $Dy^{165}-Ho^{165}$ was measured. Three lines with the following conversion ratios were found: $\gamma_1$ at 92.00 ± 0.15 kev, $K : L_1 : L_2 : L_3 : M : N = (6.6 \pm 0.7) : 1.0 : (0.103 \pm 0.006) : (0.048 \pm 0.004) : (0.19 \pm 0.01) : (0.059 \pm 0.005)$; $\gamma_2$ at 27.8 ± 0.2 kev, $K : L = 4.3 \pm 0.6$; $\gamma_3$ at 362.6 ± 0.25 kev, $K : L = 7.9 \pm 0.8$. (tr-auth)

**4813** REQUIREMENTS OF MONITORING APPARATUS FOR THE MEASUREMENT OF LOW ACTIVITIES. W. Schroeck-Vietor (Kernforschungsanlage, Jülich, Ger.). Atomwirtschaft, 7: 474-81(Oct. 1962). (In German)

The demands on monitoring apparatus for the measurement of low activities are laid down in the light of biological, physical, and legal requirements. Information which is necessary for the physical-technical design of monitoring equipment is, in so far as it is not contained in the first radiation protection regulation in force in Germany, given in the physical and biological data of the ICRP. An important conception in the design of monitoring equipment is that of the permissible duration of peak values or the time interval in which the maximum permissible value should not, on the average, be exceeded. The demand that the maximum permissible value should not be exceeded at any instant of time or at any position cannot be realized on technical grounds because of the generally non-uniform distribution and of the time required for the accumulation of a measurable dose. The lower limits of space and time are determined by the probe volume used in the measurement and by the time required to accumulate in the detector the number of counts corresponding to a definite statistical error. Continuously recording monitoring equipment should be installed in all cases in which the occasional or continuous occurrence of significant contamination in air or drinking water is involved. By significant contamination is meant that which amounts to more than 10% of the currently accepted maximum permissible value. The monitoring equipment should, according to its intended purpose, permit the measurement of at least this maximum permissible dose or one tenth of it. A reasonable basis for the design of the equipment may therefore be that at a lower measuring limit of 10% of the maximum permissible contamination a measuring accuracy of 10 to 20% of this value is sufficient. The time delay of the indicator, conditioned by the necessary collection time, by a possible transport time of the filter band and by the time constant of the measuring arrangement in use, should not be so long that the occurrence of considerable contamination in the interval would result in the inhalation of an intolerable quantity of radioactive material. (auth)

**4814** MEASUREMENT OF THE RADIOACTIVITY IN AIR. E. Kowalski (Landis and Gyr A. G., Zug, Switzerland). Atomwirtschaft, 7: 481-6(Oct. 1962). (In German)

There are several possibilities for measuring air activity: immediate measurement of the concentration of activity; measurement after increasing the concentration of activity by a non-selective enrichment, e.g., by separation of the aerosols in a mechanical or electrostatic filter; measurement after the selective enrichment of a particular radioactive isotope or of a group of related isotopes by simple physicochemical methods; radiochemical or, more accurately, mass spectroscopic analysis of air activities after previous enrichment. An immediate measurement of air activity is possible with counters or an ionization chamber but the attainable detection limits are too high because of the natural background activity. A direct activity measurement in an air flow ionization chamber is used for the determination of non-accumulating activities of inert gases. Two general requirements are placed on any measuring apparatus; the detection sensitivity for different isotopes must lie sufficiently below the tolerance concentrations; the detection delay must be so short that, at any desired concentration of activity, any possible activity taken up by the organism in the time between the occurrence and the detection of the contamination does not exceed the tolerable amount. The limits of a direct method of measurement are examined first in the light of the conditions in a simple ionization chamber with radioactive gas filling. Subsequently a tritium monitor is dealt with in which the radiation detectors are ionization chambers. A tritium concentration of $5 \cdot 10^{-7} \mu c/cm^3$ is established as the lower detection limit. This corresponds to one tenth of the tolerance concentration of tritium in its more dangerous form of water vapor for a 168-hour week. (auth)

**4815** METHODS FOR THE CONTINUOUS DIRECT MEASUREMENT OF RADIOACTIVE SUBSTANCES IN WATER. H. Gebauer and S. Mueller (Frieseke and Hoepfner G.m.b.H., Erlangen-Bruck, Ger.). Atomwirtschaft, 7: 487-91(Oct. 1962). (In German)

The detection limits of former monitoring arrangements for the continuous direct measurement of radioactive substances in water were not sufficient to cover most radionucleides in concentrations below the permissible values. At first therefore the method of continuous enrichment and measurement was followed. The introduction of large surface counters for water monitoring on the Karlsruhe nuclear reactor gave fresh impetus to continuous direct monitoring. The methods of direct measurement and reports on the calibration and energy dependence of various arrangements are described. A consideration of the detection limits indicates the activity concentrations which can still be covered. All arrangements of different detectors which are important in practice and have been investigated are described. Detector systems which are in immediate contact with the water have the disadvantage that, in the course of time, the counter surface can easily be contaminated and soiled resulting in an increased background count and an increased absorption of beta radiation. In addition this arrangement with a directly immersed counter has the disadvantage that it cannot deal with low-energy beta radiation because of the large counter wall thickness which is necessary on grounds of stability. If low-energy beta radiation is to be counted the mass of the counter window should not exceed 5 mg/cm$^2$. Such thin windows can no longer be immersed in water but the possibility exists of mounting one or more counters on a flow cuvette or of arranging the detectors to be very close to the free surface of the water. For end windows of large area there are no foils which are so gas-tight that the counter filling will not diffuse through them in the course of time. In this case, methane flow counters are used which work in the proportional region and which are continuously flushed with methane as the counter gas. (auth)

**4816** DISCONTINUOUS MEASUREMENT OF THE RADIOACTIVITY IN WATER. K. Haberer (Technische

Hochschule, Karlsruhe, Ger.). Atomwirtschaft, 7: 492-7 (Oct. 1962). (In German)

The measurement problems must first be exactly defined in order to determine the most appropirate equipment for the determination of the radioactivity of water samples. Radioactivity measurements on water samples can be divided into three main groups: 1. Safety measurements which should indicate the occurrence of menacing concentrations of activity in the shortest possible time (such measurements remain limited to nuclear-technical installations and serve to prevent accidents); 2. Monitoring measurements which should check the observance of given regulations and thus the physiological innocuousness of a water or effluent. Activity concentrations which lie under a prescribed limit are, in this connection, without interest; 3. Investigatory measurements which serve to establish the general level of activity and thus to estimate the radiation dose to people at large, i.e., for the determination of the so-called population dose. In this case possibly very low actual specific activities in waters must be determined. The investigatory measurements concentrate on the determination of the additional radiation dose due to the application of nuclear energy. In order to attain a sufficiently sensitive measurement of radioactivity, it is mostly necessary to enrich the radionuclide in the water. The relationships between counting rate, background activity, and probable error are considered in detail for estimating the sensitivity of measurement. Further sections deal with the efficiency of the measuring system as well as the relative specific activities which, depending upon the window thickness and the maximum beta energy, produce the same counting rates. In the case of monitoring arrangements, large surface counters can be installed with advantage since, on the other hand, a layer as thin as possible is desirable and, on the other, adequate measuring accuracy is always available. Generally, a significantly greater accuracy is obtained at high specific activities with the large surface counter. For investigatory measurements, the results of the total beta activity determinations in fallout tests are generally referred to a potassium standard. (auth)

**4817** THE MEASUREMENT OF WEAK BETA EMITTERS IN THE GAS PHASE. H. Simon (Technische Hochschule, Munich) and F. Berthold. Atomwirtschaft, 7: 498-507(Oct. 1962). (In German)

In tracer experiments, the precision of the radioactive measurements is almost always the deciding factor as to whether an unambiguous result can be obtained, often after complicated, lengthy, and expensive investigations. The sensitivity is closely connected with the accuracy and is, moreover, decisive in determining how much must be spent on marked materials. The techniques of measurement in gas counters are compared both in principle and practice with the other usual methods and longterm experience with gas counting is reported. The gas filled counters used have brass cathodes which have proved superior to glass counters. The anti-coincidence screening counters are of unconventional construction. They consist of two concentric cylinders between which wires are stretched parallel to the axis. A fundamental advantage of this construction is the avoidance of dead zones through which a charged particle of cosmic radiation could pass without generating a screening pulse. In anticoincidence equipment it is particularly important to avoid disturbing pulses from high frequency electrical interference since the lower the background of an arrangement already is the greater is its relative increase by a given number of disturbing pulses. Particular care is necessary with proportional counters since the counting pulses are only very small. The background count of a 150 ml counter can be reduced from 160 counts/min when unscreened to 4 counts/min by screening with 10 cm of lead and an anti-coincidence arrangement. The constancy of the background effect is in general quite good with one and the same counter filling. Proportional counters have, as gas counters, a series of advantages over GM counters. In the analysis of $C^{14}$ and T-marked substances, special significance attaches to the specimen preparation. (auth)

**4818** MEASUREMENT WITH LIQUID SCINTILLATORS. E. Rapkin (Packard Instrument Co., Inc., La Grange, Ill.). Atomwirtschaft, 7: 508-11(Oct. 1962). (In German)

Liquid scintillation counting has gained ground as a popular method for the measurement of weak activities of alpha and beta emitters. It permits samples of very diverse kinds and physical constitutions to be counted and also the measurement of several radioisotopes in one specimen. An important basis for its popularity is the possibility of fully automatic operation which it offers. Modern instruments can accommodate up to 200 samples and are so arranged that either two isotopes can be assessed simultaneously in the same specimen or, alternatively, measured in different specimens. Two types of liquid scintillation counter are available on the market: coincidence counters and equipment using one photomultiplier. In spite of the advantage of being cheaper, systems with only one photomultiplier are less popular because of the high background effect, because they cannot be automated, and because of the necessary dark adaptation. In general, specimens are dissolved in the scintillator liquid, introduced into the counting chamber and the count made. Toluene is used throughout as the solvent medium, substances normally insoluble being dissolved with the aid of organic base Hyamin. In comparison with routine measurements, considerably greater care is required in the counting of very low activities such as occur in geological or archaeological dating. The carboniferous material is, in this case, burnt and the resulting $C^{14}O_2$ converted by a series of well worked out chemical reactions into a pure liquid. Conversion into benzene as an end product is preferred today. Similarly in the determination of extremely small activities of tritium in water samples conversion, via acetylene, into tritiated benzene is an excellent possibility. The liquid scintillation technique can also be employed for solid or liquid samples which are either completely insoluble or only dissolve with great difficulty in the usual scintillator solutions. (auth)

**4819** A LEAD-MERCURY SCREENING SYSTEM FOR THE MEASUREMENT OF LOW ACTIVITIES. H. Ebert and J. Gottschald (Telefunken G.M.b.H., Ulm, Ger.). Atomwirtschaft, 7: 511-14(Oct. 1962). (In German)

In order to obtain an acceptable measurement time with a given statistical error, it is necessary to realize as high a counting rate as possible through a measuring system of high efficiency and to reduce drastically the disturbing background count. The following possibilities are available to obtain a high rate: 1. The use of detectors with a high detection probability for the radiation to be measured; 2. Detectors with large dimensions which can cover a big test volume; 3. A suitable geometry, e.g., measurements in a bore-hole; 4. Increase in the specific activity of the radiator, e.g., by evaporation or by the chemical separation of as much as possible of the inactive materials. The first three possibilities lead generally to large and expensive measuring equipment whilst the fourth possibility involves the time-consuming and troublesome processing of each individual specimen. Lead, which is mostly used for screening, possesses an appreciable natural activity and lead screens with a wall thickness of over 100 mm are not therefore very useful. Because of the high beta detection probability, end window GM counters and methane flow counter arrangements are predominantly relied upon for the measurement of weak beta activities. An essentially reduced background count can be obtained with an arrangement in which the penetrating mesons are eliminated with the help of a protective counter and an anticoincidence circuit. The concentric arrangement of the hemispherical anode and cathode of the protective counter gives a higher gamma counting efficiency than that of the measuring counter so that practically all the mesons released in the measuring counter produce a pulse in the protective counter counter. The measuring counter is a beta counter of very short length. (auth)

**4820** PARTICLE DETECTORS. PART I. F. M. Russell. Instr. Pract., 16: 1349-54(Nov. 1962).

To understand how the various types of nuclear radiation detectors work, it is necessary to know something about the interaction of radiation with ordinary matter. The interactions of charged light nuclei, electrons, neutrons, and gamma and x rays with matter are discussed and examples are given. (W.D.M.)

**4821** A SIMPLE LIQUID SCINTILLATION COUNTER FOR MEASUREMENT OF $C^{14}$-LABELED COMPOUNDS. H. Koch and H. Schlegel (Institut für Angewandte Radioakivität, Leipzig). Isotopen Tech., 2: 243-6(Aug. 1962). (In German)

A simple liquid scintillation device which permits the $C^{14}$ activities to be measured with counter yields up to 66% is described. As investigations with various scintillation mixtures show, very reasonable substances, such as *p*-terphenyl, can be introduced in routine operations in combination with optical phosphors with good luminescence yield. Generally, measurements can be carried out in concentration ranges (of the substance to be measured) in which no modification of the luminescence quenching occurs. (tr-auth)

**4822** INFORMATION CAPACITY OF RADIATION DETECTORS. [PART] II. R. Clark Jones (Polaroid Corp., Cambridge, Mass.). J. Opt. Soc. Am., 52: 1193-1200(Nov. 1962).

In Part I, it was explicitly postulated that the internal noise of the detector was large compared with the noise produced by steady radiation falling on the detector (radiation noise). In this Part II both kinds of noise are taken into account. In a sense, therefore, Part II includes Part I. But in another sense the scope of Part II is more restricted because the greater complexity with respect to the sources of noise has made it desirable to use throughout the simplifying assumption that was used only in Sec. 3 of Part I. The emphasis is given not to the information capacity itself, but to the information efficiency, which is the information capacity divided by the mean power of the beam. A parameter $\beta$ is introduced that is a measure of the relative amount of the radiation noise and the internal detector noise when the mean signal power is chosen optimally. When $\beta$ is zero, only radiation noise is present, and when $\beta$ is infinite, only the internal noise is present. The information efficiency I is derived as a function of the parameter $\beta$. The two cases represented by the extreme values of $\beta$ are discussed. It is found that with symmetrical signal modulation, the maximum possible information efficiency is equal to the detective quantum efficiency of the detector. When, however, nonsymmetrical modulation is permitted, then the maximum possible information efficiency may be greater and is equal to $Q_D$ multiplied by $\log_2 (1/p)$, where p is the probability that the gate is open. The information efficiency in bits per photon is calculated for five different kinds of detectors: a multiplier phototube, human vision, photographic films, an image orthicon, and heat detectors. (auth)

**4823** THIN-WALLED CYLINDRICAL COUNTER FOR GEIGER-MÜLLER COUNTING OF LOW ENERGY BETA RADIATION. S. J. Thomson and J. L. Wishlade (Univ. of Glasgow). J. Sci. Instr., 39: 570-1(Nov. 1962).

A cylindrical thin-walled counter, 22 mm in diameter and 15 cm long, suitable for counting carbon-14 $\beta$ particles is described. The window thickness is 4.54 mg $cm^{-2}$, operating voltage 1600 v, plateaux 400 v, slope less than 2%. The efficiency of counting for particles arriving at the counter is 6−8%. (auth)

**4824** LIQUID SCINTILLATION COUNTER WITH COOLED PHOTOMULTIPLIER. Yasushi Nishiwaki (Tokyo Inst. of Tech.), Hiroshi Kawai, Yotaro Oshima, and Masaki Koyama. Japan. J. Appl. Phys., 1: 237-8(Oct. 1962). (In English)

A simplified method was devised to cool only the photomultiplier in vacuum by replacing a large refrigerator with small thermo-elements, while the sample vial is kept at room temperature outside the vacuum. The reduction of thermal noise generation in the tube was detected with a single photomultiplier. (W.D.M.)

**4825** A SIMPLE METHOD FOR THE MEASUREMENT OF THERMAL NEUTRON FLUX. H. Dresia, H. Spierling, and G. Dodt (Staatlichen Ingenieurschule für Maschinewesen Essen, Ger.). Kerntechnik, 4: 441-3(Oct. 1962). (In German)

Sodium iodide powder, which is easily soluble in water, was used in an aluminum envelope as a probe substance for the measurement of thermal neutron flux. The absolute $\beta$-activity of $I^{128}$ was measured. Up to the point of saturation activation, the activity of $Na^{24}$ remained negligibly small. The activity measurement was done, after dissolving the activated NaI powder in water, with the cup fluid counting tube which ensured reproducible measurements. The gauging of the counting tube for the determination of the absolute activity was done by way of the linear relationship between efficiency and maximum energy if $E_{max} > 0.7$ Mev. Uranium and potassium whose specific activities are known well enough were sufficient as standards. By interpolation, the efficiency for the $\beta$ radiation of $I^{128}$ can be calculated. The activation by resonance neutrons must be taken into consideration. Absorption and coincidence measurements are not required. Fluxes of about $2 \times 10^2$ $cm^{-2}$ $sec^{-1}$ can still be measured with this method. (auth)

**4826** DISC: CHERENKOV COUNTER WITH VELOCITY SELECTION. R. Meunier, J. P. Stroot, B. Leontic, and A. Lundby (CERN, Geneva). Nucl. Instr. Methods, 17: 1-19(Sept. 1962). (In French)

A class of differential Cherenkov counters with liquids or gases as radiators is described, which makes use of the essential characteristic features of Cherenkov light. The counters are directional, isochronous and self-collimating, thus called DISC. The optical system is designed so as to extract the maximum information from the Cherenkov light in the most efficient way, thus minimizing the radiator thickness. (auth)

**4827** DISC COUNTER WITH LIQUID RADIATOR. R. Meunier, J. P. Stroot, B. Leontic, A. Lundby, and P. Duteil (CERN, Geneva). Nucl. Instr. Methods, 17: 20-30 (Sept. 1962). (In French)

Construction and performance of liquid DISC (differential, isochronous, self-collimating) Cherenkov counters are described. The velocity range extends from $\beta = 0.65$ to 0.96 with a resolution $\Delta\beta/\beta \geq 0.6$ per cent. (auth)

**4828** GAMMA SPECTROMETRY WITH HIGH-FREQUENCY SUM-PEAK COINCIDENCE SPECTROMETER. J. Kantele (Univ. of Arkansas, Fayetteville). Nucl. Instr. Methods, 17: 33-43(Sept. 1962). (In English)

Methods of gamma spectrometry with a two-crystal integral-bias scintillation coincidence spectrometer described earlier were studied especially for the case of an almost $4\pi$ geometry. Detection of gamma rays with a system of this type was investigated, and methods of intensity and coincidence relationship determinations are described. The coincidence detection efficiency of the spectrometer presented is two to three orders of magnitude higher than that of comparable conventional scintillation coincidence spectrometers, which makes the system especially useful in detection and identification of multiple coincidences, as well as in study of weak sources. A comparison between the present method and some other coincidence detection technique is made. (auth)

**4829** ACOUSTIC SPARK CHAMBER. B. C. Maglic and F. A. Kirsten (Univ. of California, Berkeley). Nucl. Instr. Methods, 17: 49-59(Sept. 1962). (UCRL-10057). (In English)

Positions of the tracks produced by cosmic rays in a 15-kv four-gap spark chamber were determined by measuring the time of flight T of the shock waves produced by sparks in argon. A pair of acoustic probes, using barium-titanate piezoelectric transducers, is placed in each gap of the spark chamber. Times in μsec for each probe are measured by a time-sorter and printed 2 sec after the passage of the particle through the chamber; from these, the position and the angle of the track was reconstructed by a program. With the spark energy of 2 joules, signals of the order of 1 v are obtained from the transducer. These signals are of N-wave form, with the rise-time of 1 μsec or less. The full-width one-dimensional resolution in the spark position is 0.33 mm up to a distance of 52 cm; and 0.41 mm at 1 meter (giving an accuracy to 1 : 2500). The full-width spatial resolution, measured with three probes per gap is 0.8 ± 0.4 mm. The time-of-flight vs distance dependence is linear up to 2 meters. The recovery time of the probes is 10 μsec, suggesting the possibility of handling up to ten tracks during a long-spill accelerator pulse, with two probes per gap, and up to 20 with six probes per gap. (auth)

**4830** ON THE MEASUREMENT OF $\beta-\gamma$ CIRCULAR POLARIZATION CORRELATIONS IN FORBIDDEN $\beta$ DECAY. A. Gelberg (Inst. of Atomic Physics, Bucharest). Nucl. Instr. Methods, 17: 60-4(Sept. 1962). (In English)

The efficiency of a circular polarization analyzer used in $\beta-\gamma$ correlation measurements is calculated in the case of first forbidden beta decay. The quantity $E = 2(R_- - R_+)/R_- + R_+)$ is calculated by using the method of Rose. Determination of nuclear matrix elements can be done quite conveniently, by means of the final expression for E. (auth)

**4831** THE ANALYSIS OF CONTINUOUS SPECTRA USING THE MATRIX METHOD. R. E. Rand (University Coll., London). Nucl. Instr. Methods, 17: 65-70(Sept. 1962). (In English)

The matrix method for analyzing a pulse height distribution, obtained with a spectrometer of finite resolution, is reviewed. It is shown how the statistical errors in the energy spectrum depend on those in the experimental pulse height distribution and the response matrix of the spectrometer. Accuracy of calibration may limit the number of channels which may be used in a given analysis. A simple first order correction is developed for the quadrature error involved in the matrix method and the consequent improvement in results demonstrated. An expression for the upper limit to the number of channels which may be usefully employed in a given analysis, is suggested. The design of experiments, in which continuous spectra are measured, and the choice of suitable spectrometers, are facilitated by these results. (auth)

**4832** EFFECT OF FORWARD-VOLTAGE ION-DRAFT ON THE OPERATION OF LITHIUM-DRIFTED SILICON JUNCTION DETECTORS. H. M. Mann and F. J. Janarek (Argonne National Lab., Ill.). Nucl. Instr. Methods, 17: 71-4(Sept. 1962). (TID-15894). (In English)

The lithium-drifted junction in p-type silicon exhibits first an increase in depletion-layer thickness and then a loss of rectification as ion-drift is continued. The loss of rectification appears as an increase in reverse current, and a reduction in forward current, when lithium-donor atoms accumulate near a metal contact on the p-type surface. Larger reverse currents reduce the electric field that can be maintained within the device and impair charge collection. This deterioration of diode and detector properties is turned back by drifting lithium ions with forward voltage applied to the detector. Six detectors have been so treated and each exhibits the same behavior. Their response to internal conversion electrons from $Pb^{207m}$ and to 6 to 9 Mev alpha particles shows retraction of the sensitive region from the p-type surface as a result of treatment. Deterioration of such detectors during use can therefore be corrected by intermittent reversal of some portion of the applied voltage. (auth)

**4833** LIGHT TRANSFER IN THE CASE OF A dE/dX COUNTER WITH A PHOTOMULTIPLIER. D. Netzband (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Nucl. Instr. Methods, 17: 81-6(Sept. 1962). (In German)

By varying of the reflector material, the reflector shape, and the shape of the scintillation foil, it was possible to construct a suitable dE/dx-counter with a multiplier. The changes were suggested by some of considerations about the extension of the light in the scintillation foil. (auth)

**4834** TWO-FOLD FOCUSSING $2 \times \pi\sqrt{2}$-ANGLE BETA-SPECTROMETER. S. A. Shestopalova (Mendelejev's Inst. of Meteorology, Leningrad). Nucl. Instr. Methods, 17: 94-6(Sept. 1962). (In English)

A description is given of a new two-fold focusing $2 \times \pi\sqrt{2}$ angle $\beta$-spectrometer which has two advantages over usual instruments of this type: small scattering and small background—less than one coincidence per 40 hours. (auth)

**4835** NEUTRON DETECTION WITH GLASS SCINTILLATORS. L. M. Bollinger (Argonne National Lab., Ill.). G. E. Thomas, and R. J. Ginther. Nucl. Instr. Methods, 17: 97-116(Sept. 1962). (In English)

A systematic study is made of the characteristics for neutron detection of boron- and lithium-containing glass scintillators. The results of measurements of the optical transmission, the pulse-height distribution, and the time dependence of scintillation intensity are presented. A careful study of the pulse-height distributions for thermal neutrons shows that a major part of the width of the distributions can be accounted for in terms of well-understood statistical fluctuations. Problems associated with the application of the scintillators are considered, with special emphasis on application to time-of-flight neutron spectroscopy. As a part of these considerations, a Monte Carlo calculation is performed to obtain a complete understanding of the time uncertainties involved in the capture of neutrons in the scintillators. It is concluded that the lithium glass is an excellent detector of neutrons when large uncertainties in time (>0.3 μsec) can be tolerated, the boron glass excels when intermediate accuracy (≈30 nsec) in timing is required, but neither kind of glass is suitable for most experiments that require fast timing. (auth)

**4836** A METHOD OF MEASURING THE EFFICIENCIES FOR DETECTING HIGH ENERGY NEUTRONS IN ORGANIC SCINTILLATORS. P. H. Bowen, G. C. Cox, G. B. Huxtable, A. Langsford, J. P. Scanlon, G. H. Stafford, and J. J. Thresher (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Instr. Methods, 17: 117-22 (Sept. 1962). (In English)

The neutron detection efficiencies of two small organic liquid scintillation counters, one containing benzene ($C_6H_6$) and the other phenylcyclohexane ($C_{12}H_{16}$), were determined in the energy range 15 to 120 Mev. The method hinges on the fact that the ratio of hydrogen to carbon nuclei is different for the two scintillators so that a knowledge of the ratio of the detection efficiencies can be used to yield an absolute value for the efficiency of either counter which is calculable simply in terms of the neutron total cross sections of hydrogen and carbon. (auth)

**4837** SOME RESULTS USING BULK IONISATION SEMI-CONDUCTOR DETECTORS. C. J. Batty (National Inst. for Research in Nuclear Science, Harwell, Berks, Eng.), R. J. Griffiths, and P. E. Gibbons. Nucl. Instr. Methods, 17: 125-7(Sept. 1962). (In English)

Measurements on cooled, high-resistivity silicon detectors ($>10^9$ ohm-cm at 90°K) using 10- and 30-Mev proton beams are reported. With a negative bias, 89 ± 5% of the total charge produced by the ionizing proton in the silicon is collected. The width of the pulse height spectrum (1.5%) is comparable with the 30-Mev proton beam energy spread of 1 to 1.5%, indicating a detector resolution of 1% or better, but bad resolution (~30%) was obtained with 10-Mev protons. Other detectors not cooled sufficiently or made from material of low resistivity also gave worse resolution with 30-Mev protons and in some cases could not detect 10-Mev protons. (D.L.C.)

**4838** PHASING TWO CHOPPERS FROM A MOTOR-GENERATOR SOURCE. R. M. Brugger and K. A. Strong (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Instr. Methods, 17: 129-31(Oct. 1962). (In English)

Two Fermi-type neutron beam choppers have been successfully phased when driven by fractional horsepower synchronous motors with power supplied by a motor generator source. A simple and accurate method of varying the phase is described. Results indicate that this relatively inexpensive chopper drive system is as satisfactory for certain neutron time of flight experiments as a system employing an oscillator and power amplifiers. (auth)

**4839** A BORON-LOADED LIQUID SCINTILLATION NEUTRON DETECTOR USING A SINGLE PHOTOMULTIPLIER. G. E. Thomas (Argonne National Lab., Ill.). Nucl. Instr. Methods, 17: 137-9(Oct. 1962). (TID-16644)

The construction, circuity, and operating characteristics of a boron-loaded liquid scintillation neutron detector are described. The cell containing the scintillator is mounted directly onto a single photomultiplier chosen for high-gain and a favorable signal-to-noise ratio. The detector produced is efficient, versatile, and simple to construct and use. (H.D.R.)

**4840** ALPHA MONITOR WITH SOLID-STATE DETECTOR. E. M. Sheen (General Electric Co., Richland, Wash.). Nucl. Instr. Methods, 17: 140-4(Oct. 1962). (HW-72770) (In English)

The developed alpha monitoring instrument uses a diffused junction silicon charged-particle detector which has a sensitive area of 2 cm². The detector, covered with a 0.9 mg/cm² protective aluminized Mylar light shield, produces 87 c/m for a 520 d/m $Pu^{239}$ alpha source deposited over a one cm diameter area. With the detector in an 8 r/h Ra gamma field, the externally-adjusted instrument produces approximately 70 c/m from the same source. The background count rate is less than one c/m for both cases. The prototype, which weighs 12 ounces, has a battery life of 30 to 40 hours, and it can employ two basic circuits for either diffused-junction or surfacebarrier diode detector use. (auth)

**4841** DEPENDENCE OF LINE WIDTHS OF SCINTILLATION COUNTERS ON INTEGRATING TIME CONSTANT. P. Onno and R. E. Bell (McGill Univ., Montreal). Nucl. Instr. Methods, 17: 149-50(Oct. 1962). (In English)

The relatively slow dependence of scintillation counter line width on integrating time constant is explained. A method is described for evaluating intrinsic crystal resolution width and photomultiplier width without the use of a light flasher. (auth)

**4842** PRECISE BORING IN THE SENSITIVE VOLUME OF GEIGER-MUELLER COUNTERS BY MEANS OF PLASTIC SCINTILLATING FILAMENTS. P. Benoit-Cattin and D. Blanc (Centre de Physique Nucleaire, Faculté des Sciences, Toulouse, France). Nucl. Inst. Methods, 17: 171-3 (Oct. 1962). (In French)

Two plastic scintillating filaments of small diameter were set in coincidence and coupled with a radioactive source. The telescope produced defines a flat beam of particles. This device makes possible a careful evaluation of the sensitive volume of a Geiger-Müller counter in coincidence with the telescope. This method is applied to glass walled and externally graphited counters and the variation of the sensitive volume as a function of some parameters is pointed out. (auth)

**4843** ANGULAR CORRELATION MEASUREMENTS WITH MULTICHANNEL ANALYZERS. E. Brooks Shera and Karl J. Casper (Western Reserve Univ., Cleveland). Nucl. Instr. Methods, 17: 174-6(Oct. 1962). (In English)

A technique is described which allows the angular correlations of several radiations, each in cascade with one common gamma ray, to be determined simultaneously through the use of a multichannel analyzer. Normalization is provided by simultaneously recording both the singles and coincidence spectra using the subgrouping facilities of the analyzer. A subgroup programmer has been constructed which provides this capability while maintaining identical calibration for the two spectra. (auth)

**4844** A NEW DOUBLE FOCUSING BETA SPECTROMETER AND THE EMPIRICAL OPTIMIZATION OF ITS PERFORMANCE. A. A. Bartlett, R. A. Ristinen, and R. P. Bird (Univ. of Colorado, Boulder). Nucl. Instr. Methods, 17: 188-24(Oct. 1962). (In English)

The design, construction and performance of a double focusing electron spectrometer are described. The spectrometer has a mean radius of 30 cm, and a maximum transmission of 5% of 4π, at a resolution of 1.5%. Resolutions of 0.07% have been obtained at a transmission of 0.5% of 4π with a source 0.020 inches wide. Three separate criteria of optimum performance have been studied experimentally; the elimination of aberrations associated with $\phi_z$, the elimination of aberrations associated with $\phi_r$, and an intermediate focusing in which the $\phi_z$ and $\phi_r$ aberrations are equal and overlap. The performance of this spectrometer under the first of these three criteria is described in detail. (auth)

**4845** COINCIDENCE COUNTING OF SPECIAL SAMPLES. R. F. Overman (E. I. Du Pont de Nemours and Co., Aiken, S. C.). Nucl. Sci. Eng., 14: 249-53(Nov. 1962).

A beta-gamma coincidence counting technique was developed to analyze nuclide pairs such as $Zr^{95}-Nb^{95}$ and $Ru^{103}-Ru^{106}$ that are unresolvable by gamma spectrometry. The method provides a means of correcting the count rate for solids on the sample plate so that solids-free mounds or mounts on thin films are not required. (auth)

**4846** A NEW GAMMA SENSITIVE IONIZATION CHAMBER FOR HEALTH MONITORING. A. L. Gray (Plessey Nucleonics Ltd., Northampton, Eng.). Nuclear Power, 7: No. 77, 60-1(Sept. 1962).

An ionization chamber is described that has collector insulation values above $10^{14}$ ohms and very low microphone noise. The electrodes consist of concentric cylinders, terminated at one end by hemispheres and at the other by a support assembly containing all the necessary connections. A typical filler-gas pressure is 20 atm, and the gas may be chosen for gamma or slow or fast neutron detection. The low microphony makes the detector suitable for portable applications. (T.F.H.)

**4847** A METHOD OF PRODUCING A LAYER OF ZnS SCINTILLATOR FOR AN ALPHA PARTICLE DETECTOR. Andrzej Kostyrko, Artur Wisniewski, and Krzysztof Zarnowiecki (Inst. of Nuclear Research, Division of Dosimetry, PAN, Warsaw). Nukleonika, 7: 425-8(1962). (In Polish)

Of the numerous methods of applying a very thin layer of ZnS particles to the face of a photomultiplier tube, the method that provides the most uniform layer is that of sedimentation. The resulting layer is very subject to shock that disturbs the uniform layer. The sedimentation layer was deposited on a sheet of plexiglas (methyl polymethacrylan). After drying, the ZnS(Ag) and plexiglas were exposed to chloroform vapor that softened the plexiglas, resulting in the ZnS becoming embedded in and permanently bonded to the plexiglas. No layer of the plexiglas covers the upper surface of the ZnS, so that the full energy of the alpha particle can be absorbed in this scintillator. Uniform layers of varying thickness (2 to 20 mg/cm$^2$) were produced. Many forms of ZnS particles (powder) were tried, and in increments of thickness of 1 mg/cm$^2$. One powder gave a count-rate saturation for 4 mg/cm$^2$ of ZrS and would therefore give the smallest gamma-ray background. A thin sample of natural uranium (28,800 decays/min) was used as an alpha test source. (TTT)

**4848** HIGH-PRESSURE X-RAY CHAMBERS. Jan Przedmojski (Warsaw Polytechnik). Postepy Fiz., 13: 455-61(1962). (In Polish)

Three types of high pressure x-ray chambers are reviewed: gas pressure, liquid pressure, and solid-piston pressure chambers. In the first two, the small sample being compressed and x rayed is embedded in gaseous or liquid matter and the pressure is transmitted to the sample by the surrounding fluid medium. In the third, pressure is applied to the sample by a solid piston device. The gas chambers, usually utilizing helium gas, are limited in pressure to about 5000 kg/cm$^2$; the liquid to about 15,000 kg/cm$^2$; and the solid to 30,000 kg/cm$^2$, using a beryllium window for the x rays. With the use of diamond instead of beryllium, pressures of about 40,000 kg/cm$^2$ were achieved. References are given for each type of chamber construction. A cross section view of a design is given for each type of chamber. (TTT)

**4849** SEMICONDUCTOR JUNCTION BARRIER DETECTORS FOR IONIZING RADIATION. Ludwik Kowalski (Warsaw Polytechnik) and Pierre Radvanyi. Postepy Fiz., 13: 463-92(1962). (In Polish)

A review of both grown-barrier and surface-barrier semiconductor devices for the detection of ionizing radiation is presented. One hundred and eighteen references are included. Both silicon and germanium semiconductor devices are covered. The fundamentals of charge carriers are reviewed, covering the magnitude of current collected, the velocity of the charge carriers, the thickness of the active layer, and the range of heavy ions in the semiconductor material. Many of the significant electrical and physical properties of specific semiconductor devices are tabulated for a large number of commercial detectors. Application of the devices to heavy ion spectrometry is well covered, including the response function for many of the geometries and associated electronics employed, the energy resolution of the devices and their linearity to protons, alphas and fission fragments. The lithium-sandwich neutron detector is also discussed, including the response function as measured both with and without the use of a coincidence circuit. (TTT)

**4850** EXPERIMENTAL DETERMINATION OF ABSORBED DOSE FROM X-RAYS NEAR THE INTERFACE OF SOFT TISSUE AND OTHER MATERIAL. Catharine L. Wingate, W. Gross, and G. Failla (Columbia Univ., New York). Radiology, 79: 984-1000(Dec. 1962).

Studies were made on the radiation dose distribution curve on both sides of a bone-soft tissue interface outward to distances comparable to the maximum electron range in the material. Plastics and glasses having compositions equivalent to muscle and bone were used. Since the errors and uncertainties vary with beam energy, chamber spacing, and the arrangement of plate materials, it was difficult to assign a single experimental uncertainty to the result. It was possible, however, to estimate the maximum uncertainty for the worst conditions and then state that most of the results are much more accurate. (P.C.H.)

**4851** $Sr^{90}-Y^{90}$ BETA-RAY (AND BREMSSTRAHLUNG) DEPTH-DOSE MEASUREMENTS IN LUCITE. Amrik S. Chhabra (Argonne National Lab., Ill.). Radiology, 79: 1001-7(Dec. 1962). (TID-14735)

In order to investigate the extent to which nuclear emulsions can be used in beta-ray dosimetry, depth-dose measurements of $Sr^{90}-Y^{90}$ radiation in Lucite were first made by using a plastic scintillator (NE102) and a Failla extrapolation ion chamber down to and beyond the beta-ray range. Very good agreement was found between these methods throughout the region of beta rays and bremsstrahlung. Measurements with NTB emulsion, however, proved to be grossly inadequate in regions where the absorbed dose is due mostly to bremsstrahlung. From the depth-dose measurements made with the scintillator, isodose curves were constructed for the particular applicator, covering a dose-rate range of $10^5$. (auth)

**4852** THIN SEMICONDUCTOR TRANSMISSION-COUNTER SYSTEM FOR NUCLEAR PARTICLE DETECTION. Jack H. Elliott and Richard H. Pehl (Univ. of California, Berkeley). Rev. Sci. Instr., 33: 713-15(July 1962).

Sturdy silicon transmission counters as thin as 0.0012 in. were produced and used in conjunction with a passive pulse-adder circuit which combined the dE/dx and E pulses so that the nonuniformity and energy straggling in the transmission counter would not decrease the resolution of the energy spectra. Construction and performance of these counters were described. (auth)

**4853** DISTORTION OF PROPORTIONAL COUNTER SPECTRA BY COUNTER POISONS. C. F. Smith, Jr. and D. C. Conway (Purdue Univ., Lafayette, Ind.). Rev. Sci. Instr., 33: 726-9(July 1962).

Distorted spectra are obtained when the Mn K x-ray peak is observed in a proportional counter filled with $CO_2$ and small pressures of the counter poison $O_2$. The spectra can be explained with the assumption that the only effect of the poison is to capture electrons as they drift toward the anode. The rate of attachment of electrons at an average electron energy of 0.054 ev and 298°K is found to be equal to $K_2(O_2) + K_3(O_2)(CO_2)$, where the values of $K_2$ and $K_3$ are $5 \times 10^{-12}$ cc/sec and $1.7 \times 10^{-30}$ $cc^2$/sec, respectively. (auth)

**4854** TOTAL-ABSORPTION SCINTILLATION COUNTER FOR HIGH-ENERGY PHOTONS. William C. Bowman, Jim B. Carroll, and John A. Poirier (Univ. of California, Berkeley). Rev. Sci. Instr., 33: 741-3(July 1962). (UCRL-10102)

A total-absorption scintillation counter for high-energy photons is developed with ±7% energy spread for 130-Mev photons. The counter is built of enough plastic scintillator to contain most of the energy and maintain a high detection efficiency. The technique of observing a statistical sampling of light from an integrating volume is used. The integrating volume is obtained by painting the surface of the counter with a diffuse reflector and detecting the light with a large number of photomultiplier tubes placed symmetrically about the counter. Use of a scintillator enabled the use of a light source of high intensity, thus assuring optimum photon statistics. (auth)

**4855** USE OF GUARD-RING SILICON SURFACE-BARRIER DETECTORS IN BETA SPECTROMETRY. R. J. Fox and C. J. Borkowski (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 33: 757(July 1962).

Conversion-electron spectra of $Bi^{207}$ and $Cs^{137}$ obtained using guard-ring Si surface-barrier detectors, operating with bias voltages of 1.0 to 1.8 kv, are shown to demonstrate the performance of these detectors in beta spectrometry. (T.F.H.)

**4856** HIGH-CURRENT FAST-TRIGGERING SYSTEM FOR SPARK CHAMBERS. M. Conversi, L. di Lella, and M. Toller (Università, Rome). Rev. Sci. Instr., 33: 777-8 (July 1962).

A three-electrode spark gap, which is triggered by a power tube, is designed as a triggering device for spark chambers. The spark gap is illuminated by uv light, in order to suppress jitter during the gap breakdown. The time lag between the coincidence input (caused by particle traversal of the spark chamber) and breakdown of the spark chamber is always less than 100 nsec. (T.F.H.)

**4857** USE OF LITHIUM-DRIFTED DIODES IN BETA AND GAMMA SPECTROMETRY. J. L. Blankenship and C. J. Borkowski (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 33: 778-80(July 1962).

The performance of Li-drifted $p^+$-i-$n^+$ diode detectors, which have thin dead layers and deep sensitive volumes, is described for beta, x-ray, and gamma spectrometry at energies below 100 kev. The use of these detectors in measurements of the electron and photon spectra of $Bi^{207}$, $Pb^{207}$, and $Cs^{137}$ is shown. (T.F.H.)

**4858** AN EXTRAPOLATION CHAMBER AS STANDARD MEASURING APPARATUS FOR ENERGY-RICH PHOTON AND ELECTRON RADIATION. Siegfried Rase and Wolfgang Pohlit (Max-Planck-Institut für Biophysik, Frankfurt am Main). Strahlentherapie, 119: 266-77(Oct. 1962). (In German)

An extrapolation-ionization chamber, which can be used as a standard instrument for dose determinations of high energy radiation (bremsstrahlung above 2 Mev, fast electrons above 0.5 Mev), is described. The construction was chosen in such a way that all necessary correction factors can be determined with the standard instrument itself. It is also a reliable standard instrument for high energy radiation. (auth)

**4859** KERNSTRAHLUNGSMESSGERÄTE. (Nuclear Radiation Measuring Apparatus). Kurt Langhans, ed. Berlin, Deutscher Militärverlag, 1960. 326p.

Methods and apparatus for detecting and measuring nuclear radiation are described with emphasis on their use in protection against radiation from nuclear weapons. Topics covered include: radiation from nuclear weapons; the scope of radiation measurements; characteristics for use in the evaluation of radiation measurements; electric luminescent, chemical, path analysis, calorimetric, and biological methods of measurement; measuring apparatus for military purposes; calibration over the ranges of the radiation measuring instruments; and examples of practice apparatus. (M.C.G.)

**4860** SIMPLE CONSTRUCTION OF THE $CO_2$ PROPORTIONAL COUNTERS DESIGNED FOR $C^{14}$ DATING MEASUREMENTS. W. W. Mościcki and A. Zastawny (Gdańsk-Wrzeszcz, Lab., Poland). IAEA Preprint No. SM-33/31. 10p. (In English)

To be published in the Proceedings of the IAEA Symposium on Radioactive Dating, Athens, Greece, 19-23 November 1962.

It is known that proportional counters filled with pure $CO_2$ designed for age determination require particular construction to reduce the radioactive contamination and to keep the filling gas free from even the traces of electronegative gases. Other difficulties arise because of the need to insulate the cathode against the anti-coincidence shield. All difficulties were overcome by the use of the quartz wall counter. In many laboratories the exclusively necessary materials are not available, however, and other means are used. The influence of some insulating materials introduced into the volume of the proportional $CO_2$ counter made of glass and metal on its characteristics is mentioned briefly. The construction of two counters is presented: one with internal and the other with external anti-coincidence ring, using epoxy resin and transformer oil as insulators. The characteristics of the counter of 2.5 liter effective volume, used for two years in the Gdańsk Laboratory, are described. With $CO_2$ pressure of 1 atm and discrimination of pulses less than 10 mv, the pulses begin to appear at 5100 volts. The steepest increase of the counts is observed at about 5400 volts. The slope of the characteristics in this region, essential both for the choice of the right working point and for the test of purity of $CO_2$, is above 50%/100 volts. At about 6000 v the plateau begins with a slope of about 0.5% for the $C^{14}$ electrons, about 0.3% for the cosmic ray component, and about 0.9% per 100 v for the background. The length of the plateau is about 1100 volts. For unexplained reasons, the counter shows small irreproducibility of counts in the first 10 to 20 hours after filling and the characteristic tends to shift some 50 to 100 volts toward the lower values. A small memory effect was observed. (auth)

**4861** IMPROVEMENTS IN OR RELATING TO APPARATUS FOR USE IN SURVEYING FOR RADIOACTIVE SUBSTANCES. Kikuo Takahashi. British Patent 909,207. Oct. 31, 1962.

The design is discussed for an apparatus comprising a crystal which emits light when exposed to gamma rays, a photo-electric device for converting this light into electrical signals, and a lead shield surrounding the crystal and mounted for rotation about an axis extending through the crystal. The lead shield is provided with a through hole with which the crystal is aligned. (R.J.S.)

**4862** IMPROVEMENTS IN OR RELATING TO CONDENSER CHAMBER DOSIMETERS. Wilfred Abson (to United Kingdom Atomic Energy Authority). British Patent 909,719. Oct. 31, 1962.

A condenser chamber dosimeter is described which consists of a casing constituting an electrode and contains two further electrodes arranged coaxially. A pair of the three electrodes are insulatedly secured to the third electrode and are radially spaced to define between them the sensitive volume of the chamber. (R.J.S.)

**4863** SCINTILLATION COUNTER FOR NEUTRONS AND GAMMA RAYS. Arthur H. Youmans (to Well Surveys, Inc.). U. S. Patent 3,062,957. Nov. 6, 1962.

A scintillation counter has been designed to detect neutrons and gamma rays in a borehole. Fluorescent media in conjunction with photomultipliers are used to detect the radiation. A Dewar flask is employed to protect the counter from excessive temperatures. (R.J.S.)

**4864** METHOD AND APPARATUS FOR THE MEASUREMENT OF A FLUX OF NEUTRONS. Pierre Georges Le Clerc (to Compagnie de Saint-Gobain). U. S. Patent 3,065,345. Nov. 20, 1962.

An apparatus is described that was designed to measure the flow of neutrons and to assay the quantity of neutrons received by a body subjected to irradiation. The neutron dosimeter contains a heterogeneous glass analyzer having zones of different glasses that react differently to neutrons. (R.J.S.)

**4865** RADIOACTIVE BOREHOLE LOGGING APPARATUS. John T. Dewan and Orville L. Stone (to Schlumberger Well Surveying Corp.). U. S. Patent 3,065,346. Nov. 20, 1962.

An apparatus is described for logging gamma radiation in a borehole, to the exclusion of gamma rays resulting from capture of neutrons in the borehole fluid, the pressure housing, or the casing. (R.J.S.)

**4866** RADIATION MEASURING EQUIPMENT. David Robinson Cockbaine and James Finston Hogg (to United Kingdom Atomic Energy Authority). U. S. Patent 3,065,348. Nov. 20, 1962.

The design of radiation measuring equipment that contains an ionization chamber and a d-c amplifier which measures the current produced in the chamber by the ionizing radiation is discussed. (R.J.S.)

**4867** RADIATION METER. Gerald J. Achtellik and James M. Constable (to Electronic Products Co.). U. S. Patent 3,065,349. Nov. 20, 1962.

The design of a portable instrument for measuring penetrating radiation is discussed. The instrument uses a Geiger-Müller tube and is powered by self-contained flashlight batteries. (R.J.S.)

**4868** NEUTRON DETECTOR. Bernard R. Linden (to Fairchild Camera and Instrument Corp.). U. S. Patent 3,067,329. "Application date Mar. 12, 1959."

This neutron detector employs a material that absorbs neutrons, but is not affected by gamma rays. When this material absorbs neutrons, it ejects particles to bombard a secondary emissive material, which thereupon frees electrons into an evacuated space. The electrons are then attracted to a collector, and suitable circuitry measures the electron flow and thus the neutron intensity. (R.J.S.)

**4869** POCKET DOSIMETER. Bernard Hess, Rolf Hosemann, and Harald Warrikhoff (to Licentia Patent-Verwaltungs G.m.b.H.). U. S. Patent 3,067,331. "Priority date May 24, 1957, Germany."

A compact pocket dosimeter is described which contains an electrometer and an element automatically responsive to radiation that supplies a corresponding electromotive force to the electrometer. Since no ionization chamber is used, recharging is not required. (R.J.S.)

**4870** CONTROLLABLE IONIZATION CHAMBER. Alfred Stebler and Klaus Unser (to Landis and Gyr A. G.). U. S. Patent 3,067,350. "Priority date June 14, 1957, Switzerland."

An ionization chamber is described having means to control the reference level of ionization current. The chamber is of rugged construction. Energy dissipation is negligible, and the adverse effect of power supply fluctuations is minimized. (R.J.S.)

# ISOTOPE SEPARATION

**4871** (AEC-tr-5526) EXPERIENCES WITH A CHEMICAL EXCHANGE PLANT FOR THE ENRICHMENT OF $C^{13}$. E. W. Becker, K. Bier, S. Scholz, and W. Vogell. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn. from Z. Naturforsch., 7a: 664-68(1952). 13p.

The construction of the four-stage separation cascade is described which was calculated in previous studies. The plant produces 0.16 mole carbon per day with a designed production concentration of 12% $C^{13}$, while the calculation was based on a production output of 0.18 mole. The production concentration of 12% $C^{13}$ is attained after a startup period of 53 hrs. (auth)

**4872** (AEC-tr-5527) THE CHEMICAL METHOD OF ISOTOPE SEPARATION AS A RECTIFICATION PROBLEM. E. W. Becker and K. Bier. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn. from Z. Naturforsch., 7a: 651-64 (1952). 37p.

A method was developed for the determination of optimum operating conditions for individual columns and column cascades with the example of $C^{13}$-enrichment. The dependency of the separating characteristics of the packed columns upon the experimental parameters of interest was determined in 60 individual experiments. The separation efficiency of the columns could be improved considerably by a special activation process. With the experimentally obtained data, a production of 0.18 mole carbon per day with 12% $C^{13}$ was calculated for a four-stage separation cascade on the basis of the derived formulas. (auth)

**4873** CONTROL OF THE DUAL TEMPERATURE EXCHANGE PROCESS FOR THE MANUFACTURE OF HEAVY WATER. J. W. Morris and W. C. Scotten (E. I. du Pont de Nemours and Co., Aiken, S. C.). Chem. Eng. Progr., Symp. Ser., 58: 26-38(1962).

The extraction of heavy water from natural water by dual-temperature exchange with hydrogen sulfide gas required the development and utilization of unusual concepts of process control and the solution of difficult problems in the measurement and control of process flows. The basis for control was a highly sensitive ratio of the concentrations of heavy water at selected points in the process. This ratio permitted detection of deviations of as little as ½% in critical flow rates. The ratio of liquid flow to gas flow in the process must be maintained very close to an optimum. Deviation in either direction caused loss in production rate, and a sustained deviation can cause large losses of in-process inventory. The concentration ratio that was utilized for control provided a sensitive guide to both direction and magnitude of flow changes that were required to maintain process operation at high efficiency. Flow and pressure measurements were reliably made despite fouling and corrosive conditions in liquids, condensation of hot vapors, and the formation of the solid hydrate of hydrogen sulfide in process fluids at temperatures below about 30°C. Conventional orifice metering techniques were used, augmented by special provisions which included isolating the internal parts of meters from corrosive process materials and keeping the measuring systems above the temperature at which the hydrate can form. (auth)

**4874** NATURAL ISOTOPES. PART IV. SEPARATION BY ELECTROLYSIS. Anatol Selecki (Univ. of Warsaw). Przemysl Chem., 41: 293-6(June 1962). (In Polish)

In a review of isotope separation by electrolysis, a list of references is given, dating back to Kendall's reports in 1923. The enrichment of hydrogen gas in deuterium is considered by far the most feasible and economical of isotopes to separate by electrolysis, and, therefore, several methods of deuterium enrichment are presented. Each method is a cascade process. Each is evaluated for its relative effectiveness and economy. The importance of the type and condition of electrode and of the type of electrolyte is discussed. Although the effectiveness of separating isotopes of heavier elements by electrolysis is much more limited, on a practical basis, the separation of lithium, nitrogen, and oxygen is also touched upon. (TTT)

**4875** SEPARATION OF HYDROGEN ISOTOPES BY GAS CHROMATOGRAPHY. Edward Herbert Carter, Jr. Thesis, Knoxville, Tenn., Univ. of Tennessee, 1962. 170p.

Apparatus and procedures for the transfer, dilution, and separation of samples used in studies of the hydrogen–tritium–tritium hydride, deuterium–tritium–tritium deuteride, and hydrogen–deuterium–hydrogen deuteride systems by gas-solid elution chromatography were developed. Various elution experiments were conducted with palladium on flint quartz, silica gel, chromia-alumina, ferric oxide-alumina, and activated-alumina columns. Separation of hydrogen, tritium, and tritium hydride with palladium on flint quartz was not evidenced by elution analysis with argon carrier at column temperatures between 150-175°. The results, however, confirmed the observation that palladium can be used to concentrate tritium from hydrogen-tritium mixtures at elevated temperatures by displacement methods. Complete separation of tritium hydride and tritium was obtained on silica gel with hydrogen carrier at 77°K. Neon and helium failed to elute adequately the isotopes from the column at 77°K and inadequate resolution of tritium, tritium deuteride, and tritium hydride was observed with hydrogen carrier. An analytical determination of hydrogen, tritium, and tritium hydride in equilibrating mixtures of the isotopes was made. Under proper conditions of deactivation, resolution of hydrogen, tritium, and tritium hydride was effected on an 8-ft. chromia-alumina column at 77°K with both helium and neon carriers. Partial parahydrogen-orthohydrogen resolution was also observed. An analytical determination of the molar composition of hydrogen, tritium, and tritium hydride in equilibrating mixtures was made. A comparison between theoretically determined isotopic compositions at equilibrium (1200°K) in the $H_2 + T_2 \rightleftharpoons 2HT$ system and chromatographically determined compositions for equilibrium mixtures was also made. An 8-ft. ferric oxide-alumina column gave similar results in the resolution of hydrogen, tritium hydride, and tritium. However, under the deactivation-reactivation conditions employed, essentially complete equilibration of orthohydrogen and parahydrogen was observed with helium carrier at 77°K. Several activated-alumina columns were employed with hydrogen, helium, and neon carriers at 77°K. Various mixtures of hydrogen, deuterium, tritium, tritium hydride, tritium deuteride, and hydrogen deuteride were adequately resolved on the columns. Absolute resolution of hydrogen, tritium, and tritium hydride and of deuterium, tritium deuteride, and tritium was effected on an 8-ft. activated (370°, 8-20 hrs.) alumina column at 77°K with helium carrier. An investigation of the effect of varying degrees of column activation on the relative separation factors for various isotopic species was made. In general, higher degrees of column activation (alumina-dehydration) were found to produce most effective resolution regardless of the carrier or the method of activation employed. Adequate separation of hydrogen, tritium hydride, deuterium, tritium deuteride, and tritium was also obtained with neon carrier at 77°K. A 6-ft. activated-alumina column was effective in the resolution of hydrogen, tritium hydride, and tritium with neon carrier. With an increased number of components, less separation of the various isotopes was observed. Increased activation (340°, 53 hrs.) and increased column length (12 ft.) in general produced better resolutions of the various isotopes with hydrogen carrier at 77°K than were obtained on the shorter less-highly-activated columns. Helium and neon failed to elute the various isotopes from the highly-activated and/or longer columns in reasonable retention times. Simultaneous ionization chamber (50-ml.) and katharometer detection of hydrogen spin isomers and deuterium were also observed. (Dissertation Abstr., 23: No. 4, 1962)

**4876** APPARATUS FOR SEPARATING MIXTURES. (to Deutsche Gold-und Silber-Scheideanstalt vormals Roessler). British Patent 909,235. Oct. 31, 1962.

An apparatus is described for separating gas mixtures or isotope mixtures in gaseous form by means of a centrifuge running in vacuo. (R.J.S.)

# MATHEMATICS AND COMPUTERS

**4877** (CNEN-141) "SOPHY"—TWO GROUP, TWO CORE TOTALLY REFLECTED CYLINDRICAL REACTOR DESIGN CODES FOR IBM-650. P. Azzoni, F. Casali, F. Pierantoni, and P. Poli (Italy. Comitato Nazionale per l'Energia Nucleare. Centrodi Calcolo, Bologna). Jan. 1962. 34p.

The SOPHY is a two-group, two-core totally reflected cylindrical reactor design code for IBM-650 computer. The tensorial properties of the diffusion coefficients and the asymmetries in the axial reflectors have been considered. The option of the code includes the choice of the eigenvalues. $R_1$ (internal core radius), (SOPHY 1); $R_1$ (internal core radius with a flat flux), (SOPHY 2); and $B_2^2$ (external region buckling), (SOPHY 3). The calculation of the axial and the radial fluxes and of the radial adjoint fluxes is included. (auth)

**4878** (TID-17355) RESEARCH IN DIFFERENTIAL TOPOLOGY AND ON ALGEBRAIC STRUCTURES. Oswald Wyler (New Mexico. Univ., Albuquerque). Oct. 1962. For Sandia Corp., Albuquerque, N. Mex.). Contract [AT(29-1)-789]. 80p. (SCDC-2933)

The homomorphism theorem and the isomorphism theorems, including the Lemma of Zassenhas, for algebraic structures with composition laws that need not be universally defined are presented. Categories of manifolds and of fiber bundles are being studied in terms of atlases. The construction of a fiber bundle from an atlas is described. An axiomatic study was made of non-linear connections on a differentiable manifold, in a semi-classical setting. Tensors and their operations are defined invariantly. The concept of a tensor subfield is introduced. Studies were also made of a class of categories in which exact sequences of maps can be defined and their functional properties proved. (M.C.G.)

**4879** A SIMPLIFIED METHOD OF OBTAINING THE INFINITESIMAL OPERATORS OF THE HOMOGENEOUS LORENTZ GROUP. II. CALCULATIONS. B. Kuchowicz (Inst. of Nuclear Research, Polish Academy of Science, Warsaw). Bull. acad. polon. sci., Sér. sci., math., astron. et phys., 10: 287-92(1962). (In English)

The explicit form of the infinitesimal operators of the proper homogeneous Lorentz group in its canonical basis is calculated. It is shown that this form can be determined from commutation relations. Only representations that are unitary are taken into account. (T.F.H.)

**4880** OPTIMUM ALTERNATING-DIRECTION-IMPLICIT ITERATION PARAMETERS FOR A MODEL PROBLEM. E. L. Wachspress (Knolls Atomic Power Lab., Schenectady, N. Y.). J. Soc. Ind. Appl. Math., 10: 339-50 (June 1962). (TID-13114; KAPL-P-2233)

The Chebyshev minimax theory is developed for the model problem encountered in the analysis of alternating-direction-implicit iteration schemes. An algorithm for computing optimum iteration parameters is described for the case where the number of iterations is an integral power of two. (D.L.C.)

**4881** TABLES OF SECANT INTEGRALS OF THE FIRST AND SECOND KINDS. H. E. Hungerford (Atomic Power Development Associates, Inc., Detroit). Nucl. Sci. Eng., 14: 312(Nov. 1962).

A class of integral functions which most frequently be evaluated in working shielding problems and other problems involving the attenuation of radiation through shields is the class known as the secant integrals. The secant integrals of the first and second kinds were computed by numerical integration on an IBM-650. (W.C.M.)

**4882** A UNIFIED APPROACH TO MONTE CARLO METHODS AND AN APPLICATION TO A MULTIGROUP CALCULATION OF ABSORPTION RATES. J. Spanier (Westinghouse Electric Corp., Pittsburgh). SIAM (Soc. Ind. Appl. Math.) Rev., 4: 115-34(Apr. 1962). (WAPD-T-1393)

A unified description of Monte Carlo methods in particle transport problems from a mathematical point of view is presented. The basic connection between the physical and probability models is established, and analog processes are discussed. Non-analog processes are discussed in the framework of a general treatment of importance sampling. Some of these ideas are applied to the estimation of thermal absorption probabilities in a two-dimensional multigroup model. (D.L.C.)

**4883** DIFFUSION FUNCTIONS FOR SMALL ARGUMENT. Walter Gautschi (Oak Ridge National Lab., Tenn.). SIAM (Soc. Ind. Appl. Math.) Rev., 4: 227-9(July 1962).

Series expansions are given which are rapidly convergent when x is small. These are derived by noting the relation to theta functions and applying Poisson's transformation formulas which convert small arguments into large ones. (R.J.S.)

**4884** THE INTEGRAL REPRESENTATION FOR COULOMB GREEN FUNCTION. V. F. Bratsev and E. D. Trifonov. Vestnik Leningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 36-9(1962). (In Russian)

The integral representation for the Coulomb Green function was obtained with the help of stereographic projection of momentum space into the four-dimensional sphere. (auth)

# METALS, CERAMICS, AND OTHER MATERIALS

## General and Miscellaneous

*Refer also to abstracts 5037 and 5038.*

**4885** (AD-274971) THEORETICAL AND EXPERIMENTAL RESEARCH ON THERMOELECTRICITY. Scientific Report No. 8 (Final). (Massachusetts Inst. of Tech., Cambridge. Energy Conversion and Semiconductor Lab.). Jan. 15, 1962. Contract AF19(604)-4153. 12p. (AFCRL-62-149)

Results of research on energy conversion and semiconductor development are presented. Most significant developments are reported in evaluation techniques and equipment for examining thermoelectric parameters and preparation of $Bi_2Te_3$, PbTe, HgTe, CdTe, Hg−CdTe, and Bi−Sb−Te−Se. Other research is reported on thermoelectric analysis and design. (J.R.D.)

**4886** (AD-275610) RESEARCH ON MATERIALS, PROCESSES, AND DEVICES RELATED TO ENERGY CONVERSION. Semiannual Technical Summary Report No. 2. (Massachusetts Inst. of Tech., Cambridge. School of Engineering). Mar. 30, 1962. Contract Nonr-1841(78). 180p.

Research progress is reported on high-temperature thermoelectric and thermionic materials, thermal electric energy conversion, thermionic energy conversion, superconducting materials, superconducting systems, and electrochemical energy conversion. (M.C.G.)

**4887** (ANL-FGF-393) PLUTONIUM FUEL PROGRAMS AT ARGONNE NATIONAL LABORATORY. Frank G. Foote (Argonne National Lab., Ill.). Sept. 1962. Contract [W-31-109-eng-38]. 26p. (UAC-6907).

The composition of the fuel depends to a large extent upon the nature of the reprocessing method chosen for recycling. Short-cooled fuel is melted and held molten in a zirconium oxide crucible whereby fission gases and volatile fission products are vaporized and rare earth elements are oxidized by reaction with the crucible. Zirconium, molybdenum, technetium, ruthenium, rhodium, and palladium are not at all or only partially removed and remain with the fuel alloy. To prevent the continual buildup of residual fission products, a portion of the melt-refined fuel is subjected to a secondary operation which removes these residuals. After many recycles, the equilibrium fuel will contain residual fission products as alloying elements. The reprocessed fuel is highly radioactive and must be refabricated into fuel elements by remote methods in heavily shielded enclosures. (R.J.S.)

**4888** (GA-3109) SUMMARY OF COATED-PARTICLE-FUELS DEVELOPMENT AT GENERAL ATOMIC FOR THE PERIOD OCTOBER, 1961 TO APRIL 1962. Walter V. Goeddel, ed. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Apr. 26, 1962. Contracts AT(04-3)-314 and AT(04-3)-167. 20p.

Results of thermal-compatibility and irradiation testing of coated fuels are described. Some work on pyrolytic carbon coatings deposited and annealed at temperatures above 1400°C and recent applications of microradiography to coated-fuels evaluation are also discussed. Development of advanced graphite-matrix, dispersion-type fuel systems has been initiated. (R.J.S.)

**4889** (EURAEC-322) SINTERED URANIUM OXIDE–SINTERING TECHNIQUES–BEHAVIOUR UNDER IRRADIATION. Quarterly Report No. 6, January 1–March 31, 1962. (France. Commissariat à l'Energie Atomique, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 031-60-10 RDF. 81p. A translation.

The laboratory rotary furnace was calibrated in temperature and in solid flow. Tests were conducted by isolating the central fraction which produces a stationary flow in the furnace. A comparative examination was made of the results of sintering $UO_2$ pellets formed without binder by the processes of double or single compression. Industrial facilities tested comprised a rotary reduction furnace for handling $UO_2$, the utilization of forming processes without compacting binder, and a new continuous furnace. A micrographic method was developed for disclosing small stoichiometry differences produced by superficial reoxidizing of sintered $UO_2$ during its industrial preparation. A method was studied for the estimation of the O/U ratio by loss of weight during reduction in hydrogen. Stainless steel–Zircaloy-2 brazing tests with copper filler resulted in joints that were leaktight after brazing, but became porous and cracked after thermal cycling. Junctions in which the outside part is made of stainless steel and the placing of the junction in a constantly cooled part of the capsule were suggested. Tests were made to define the best conditions for the storage and the degassing of $UO_2$ pellets after sintering for the study of rare gas diffusion. The conception of the high temperature capsule associated with the in-pile experiment was slightly modified as a result of under-load alumina creep tests at 1400°C. The bench loop performed satisfactorily. The use of ceramic tubes for the diffusion furnace was not entirely satisfactory and a new furnace with molybdenum tubes was constructed. The influence of preliminary $UO_2$ treatments was studied. It appeared preferable to treat $UO_2$ in hydrogen at temperatures above 1000°C, or to forego all heat treatment before canning. (R.J.S.)

**4890** MICROGRAPHIC STUDY OF METAL DEPOSITS ON INCANDESCENT FILAMENTS. Jose Terraza Martorell, Manual Lopez Rodriguez, and Luis M. Saenz de Tejada Gonzalez (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 58: 491-6(June 1962). (In Spanish)

Metal purification by Van Arkel's method is studied. Experimental evidence shows that the process along a $VI^{1/2}$ = const. line is not isothermal. Temperature dependence of grain size and nonmetallic inclusions are studied. Isothermal processes can be obtained if the equation $VI^{\alpha}$ = const. is followed, where the value of $\alpha$ depends on deposition temperature and initial diameter of the filament. These values may vary between 1/4.3 and 1/5.5. All experiments have been carried out by deposition of zirconium on hot tungsten filaments. (auth)

**4891** PYROLYTIC GRAPHITES: THEIR DESCRIPTION AS SEMIMETALLIC MOLECULAR SOLIDS. Claude A. Klein (Raytheon Research Div., Waltham, Mass.). J. Appl. Phys., 33: 3338-57(Nov. 1962).

An investigation is reported of the electrical, the galvanomagnetic, and the thermoelectric properties of pyrolytic graphites whose morphological features are conditioned by the deposition temperature, the heat treatment, and the doping level. (auth)

**4892** METHOD FOR CONTROLLED MULTICOMPONENT SPUTTERING. W. Robert Sinclair and F. G. Peters

(Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Sci. Instr., 33: 744-5(July 1962).

A method for sputtering simultaneously from electrically independent electrodes is described. The important design consideration is that the electrodes (cathodes) are enveloped by a single Crooke's dark space. Using this technique, alloy films (or in the case of reactive sputtering, mixed compound films) can be obtained. Since the electrodes are independent, the composition gradient (in depth) of the film can be varied at will by proper variation of applied voltages. (auth)

**4893** SYMPOSIUM ON RADIATION EFFECTS IN REFRACTORY FUEL COMPOUNDS. Presented at the Sixty-Fourth Annual Meeting, American Society for Testing and Materials, Atlantic City, N. J., June 27 and 28, 1961. ASTM Special Technical Publication No. 306. (American Society for Testing and Materials, Philadelphia). Mar. 1962. 200p. $6.00.

Twelve papers are included; abstracts were prepared for 7. The 5 papers previously abstracted in NSA include information on voids in irradiated $UO_2$, fission fragment tracks in thin films of $UO_2$, effects of burnup on certain ceramic fuel materials, factors controlling the release of $Xe^{133}$ from bulk $UO_2$, and continuous release of fission gas from $UO_2$ during irradiation. (P.C.H.)

**4894** SOME CONSEQUENCES OF EXCESS OXYGEN IN $UO_2$. J. A. L. Robertson (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.3-15 of "Symposium on Radiation Effects in Refractory Fuel Compounds. ASTM Special Technical Publication No. 306." Philadelphia, American Society for Testing and Materials, 1962.

The adverse effect of excess oxygen on the irradiation performance of $UO_2$ was demonstrated empirically. Subsequent in-reactor experiments confirmed the finding and helped to explain it. The thermal conductivity of nonstoichiometric uranium oxide during irradiation was deduced from thermocouple measurements, and from the observed amount of central melting for known heat ratings. The conductivity of $UO_{2.12}$ is approximately 0.8 times that of $UO_{2.0}$; for $UO_{2.19}$ the corresponding figure is 0.4. Observed differences in the diametral expansion of the sheaths supported these deductions. The consequences of accepting nonstoichiometric uranium oxide for highly rated fuel elements were estimated. It is concluded that an oxygen : uranium atomic ratio greater than 2.01 should be avoided. (auth)

**4895** THE HEAT RATING REQUIRED TO PRODUCE CENTRAL MELTING IN VARIOUS $UO_2$ FUELS. A. S. Bain (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.30-46 of "Symposium on Radiation Effects in Refractory Fuel Compounds. ASTM Special Technical Publication No. 306." Philadelphia, American Society for Testing and Materials, 1962.

Evidence of melting was observed in six different types of fuel: $UO_{2.0}$ pellets formed by cold compacting sintering; $UO_{2.12}$ pellets; $UO_{2.19}$ pellets; $UO_{2.0}$-4 mole % $Y_2O_3$ pellets; cold swaged $UO_{2.0}$; and loose compacted $UO_{2.0}$. The results show that the integrated thermal conductivity of the fuel up to its melting point is higher for the stoichiometric pellets than for any of the other types tested. (auth)

**4896** IN-PILE FISSION-GAS RELEASE FROM $UO_2$. J. B. Melehan and F. A. Rough (Battelle Memorial Inst., Columbus, Ohio). p.100-9 of "Symposium on Radiation Effects in Refractory Fuel Compounds. ASTM Special Technical Publication No. 306." Philadelphia, American Society for Testing and Materials, 1962.

Investigations were made to determine the release of fission gas from $UO_2$ and to relate the release to material properties, both chemical and structural. It was found that the quantity of gas released in the experiments was consistent with a mechanism such that the release was dependent upon the amount of surface. The results can be accounted for by a knockout mechanism or by a recoil mechanism whereby gases are released from all open surfaces. In the temperature range 500 to 1500°F, there was little temperature effect on the gas release, especially for sintered $UO_2$. (P.C.H.)

**4897** WATER-VAPOR CORROSION OF BERYLLIA. C. C. Browne (General Electric Co., Cincinnati). p.146-53 of "Symposium on Radiation Effects in Refractory Fuel Compounds. ASTM Special Technical Publication No. 306." Philadelphia, American Society for Testing and Materials, 1962.

Fundamental investigations of the reaction of water vapor with beryllia at high temperatures and under conditions of equilibrium between the gas phase and solid beryllia reveal that at a given temperature and gas flow the rate of water-vapor attack varies directly with the partial pressure of water vapor. The equilibrium partial pressure of the corrosion product varies with temperature according to the equation: $\log P_{mm} = 4.584 - 9060/T_{^\circ K}$. For turbulent flow of moist air over hot beryllia surfaces the beryllia loss rates may be calculated and are less than would be expected for saturation of the bulk air stream with corrosion product. Coating of the beryllia surface with an oxide which is not attacked at high temperatures appeared to be the most effective way of eliminating beryllia loss in moist atmospheres. (auth)

**4898** THE IRRADIATION AND EXAMINATION OF A PLUTONIUM–URANIUM OXIDE FAST REACTOR FUEL. J. M. Gerhart, J. N. Siltanen, and J. S. Cochran (General Electric Co., Pleasanton, Calif.). p.154-77 of "Symposium on Radiation Effects in Refractory Fuel Compounds. ASTM Special Technical Publication No. 306." Philadelphia, American Society for Testing and Materials, 1962.

The irradiation behavior of a $PuO_2-UO_2$ fuel was studied. Forty fuel specimens were fabricated, encapsulated, and irradiated to burnups ranging from 5000 to 99000 Mw days per ton and heat fluxes ranging from $0.5 \times 10^6$ to $1.58 \times 10^6$ Btu per hr ft$^2$. A postirradiation examination of the fuel was made to determine the fuel condition, central void characteristics, and fission gas release. The results are presented and discussed. (auth)

**4899** SOME COMMENTS REGARDING SINTERING CHARACTERISTICS IN A RADIATION ENVIRONMENT. E. A. Aitken (General Electric Co., Cincinnati). p.123-30 of "Symposium on Radiation Effects in Refractory Fuel Compounds. ASTM Special Technical Publication No. 306." Philadelphia, American Society for Testing and Materials, 1962.

Various sintering models are reviewed and their shrinkage characteristics in the initial stages are described. For most crystalline ceramics, diffusion in the bulk was considered the controlling mechanism. Beryllium oxide, however, was an exception when the sintering atmosphere contained appreciable amounts of water vapor. The effects of radiation on the sintering mechanisms were examined and a comparison was made with direct observations reported in the literature. Previously determined shrinkage rates of $Al_2O_3$ compacts were compared with those calculated from radiation-enhanced diffusion. The influence of radiation on shrinkage appeared to be significant at low temperatures. If the particle size is less than 0.1 $\mu$, enhanced diffusion from fast neutron collisions should enable measurable shrinkage to occur in a reasonable time for fluxes of $10^{12}$ nv. (auth)

**4900** MECHANISM OF IRRADIATION DAMAGE IN URANIUM MONOCARBIDE. D. G. Freas, A. E. Austin, and F. A. Rough (Battelle Memorial Inst., Columbus, Ohio). p.131-45 of "Symposium on Radiation Effects in Refractory Fuel Compounds. ASTM Special Technical Publication No. 306." Philadelphia, American Society for Testing and Materials, 1962.

Measurements of property changes such as electrical resistivity, lattice expansion, and elastic strain with irradiation exposures were undertaken in an effort to relate the changes with radiation effects mechanisms and establish a basis for predicting the behavior of uranium monocarbide under reactor conditions. Uranium carbides of about 4.6 to 5.2 wt % carbon were shown to exhibit excellent resistance to irradiation damage up to uranium burnups of 2.3 at. % and maximum core temperatures as high as 1550°F. Also, the dimensional, density, and gas-retention properties illustrated good radiation stability. The measurements of electrical resistivity however, suggest that a saturation of displaced interstitials and vacancies in the lattice was attained very early during irradiation. Measurements of radiation-induced lattice-parameter changes showed that the lattice expansion in uranium monocarbide approached an upper limit after only a short exposure. (P.C.H.)

**4901** MANUFACTURE OF NIOBIUM BY FUSION ELECTROLYSIS. Ernst Adalbert Pokorny (to Societe Generale Metallurgique de Hoboken). U. S. Patent 3,062,727. Nov. 6, 1962.

Metallic sodium is prepared by passing a direct electric current through a fused electrolyte bath of a double fluoride of niobium and an alkali metal. The bath contains a member selected from the group consisting of a rare earth metal, a rare earth metal alloy, and a rare earth metal halide. An alloy of niobium and rare earth metal is recovered. (R.J.S.)

## Corrosion

*Refer also to abstract 5590.*

**4902** (DRI-2061) AN INVESTIGATION OF THE EFFECT OF METALLIC ADDITIONS UPON THE OXIDATION RESISTANCE OF $NbAl_3$. Interim Report, September 1, 1961–August 31, 1962. Walter L. Wheatfall, Donald T. Klodt, and Charles E. Lundin (Denver. Univ. Denver Research Inst.). Sept. 1962. Contract AT(11-1)-1092. 45p.

The effect of additions of titanium, zirconium, vanadium, silicon, or tin on the air-oxidation resistance of $NbAl_3$ was investigated. $NbAl_3$-compound alloys containing up to 15 weight percent of the addition element were arc melted in a cold-crucible, non-consumable electrode arc furnace. The as-cast alloys were homogenized and then subjected to screening air-oxidation tests at 760°C in dry and humid air. Those alloy compositions which exhibited oxidation resistance throughout a 1000-hour exposure were studied by a thermogravimetric technique to determine the rate laws governing the oxidation. Also, an oxidation survey of these oxidation-resistant compositions at 1370°C was conducted. The phase equilibria of the alloys were investigated after being given isothermal anneals at 850, 1000, 1150, 1250, 1300 and 1370°C by metallographic and x-ray-diffraction techniques. The range of homogeneity of the $NbAl_3$ compound was established insofar as possible in each system. (auth)

**4903** (DRI-2075) AN INVESTIGATION OF THE EFFECT OF METALLIC ADDITIONS UPON THE OXIDATION RESISTANCE OF TITANIUM-MODIFIED $NbAl_3$. Quarterly Progress Report No. 1, September 1, 1962–November 30, 1962. Walter Wheatfall and Donald T. Klodt (Denver. Univ. Denver Research Inst.). Dec. 1962. Contract AT(11-1)-1092. 8p.

An investigation of the effect of additions of silicon, tin and a combination of chromium and silicon on the air-oxidation resistance of titanium-modified $NbAl_3$ is being conducted. Thermogravimetric studies of alloys prepared by arc melting will be made at 760, 860, 960, 1060, 1160, 1260, and 1360°C. A high-temperature thermogravimetric apparatus is being constructed for the higher temperature runs. Studies have been completed on a portion of the alloys with tin additions at the lower temperatures. Phase equilibria studies of the alloys after homogenization and isothermal annealing at 1300 and 1000°C are also being conducted to supplement the oxidation studies. (auth)

**4904** (LAMS-2779) BIBLIOGRAPHY ON CORROSION BY LIQUID METALS (1957–SEPTEMBER 1962). Helen J. Chick, comp. (Los Alamos Scientific Lab., N. Mex.). Oct. 12, 1962. Contract W-7405-eng-36. 39p.

The following sources were used: Nuclear Science Abstracts, 1957–September 15, 1962; Abstracts of Classified Reports, 1957–August 31, 1962; and LASL Report Library Catalog. References on corrosion of or by alloys of the following metals were especially sought: cerium, cobalt, iron, plutonium, tantalum, and tungsten. Type of literature covered is mainly limited to report and journal literature. Arrangement is by report number for the former, and alphabetical by the name of the first author for the latter. A total of 170 references is presented. (R.J.S.)

**4905** (NP-12334) COMPATIBILITY OF MATERIALS WITH HIGH TEMPERATURE POTASSIUM. Final Progress Report, April 18, 1960 through December 31, 1961. D. V. Hammond and T. M. Littman (Rocketdyne. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 23, 1962. Contract NAS 5-453. 143p. (R-2617-4)

The compatibility of potassium with suitable refractory containment materials was studied under conditions similar to those desired in lightweight, high-power, turbogenerator, nuclear space powerplants. Isothermal niobium alloy and superalloy capsule tests were performed in the temperature range of 1450–2200°F under both static and dynamic conditions. A superalloy Rankine cycle loop was operated at a boiling temperature of 1800°F to test various containment materials in potassium. Fabrication of two all-niobium alloy (Nb-1%Zr) Rankine cycle loops was initiated, but only one was fully completed and operated for short periods of time in a vacuum chamber at boiling temperatures up to 2000°F. (R.J.S.)

**4906** ATTACK OF FERRITIC STEELS BY THE EUTECTIC MELT OF LEAD–BISMUTH. J. C. Clifford and George Burnet (Iowa State Univ., Ames). Chem. Eng. Prog., Symp. Ser., 58: 67-73(1962). (IS-321)

The corrosion resistance of a mild steel (type C-1020), two alloy steels ($2\frac{1}{4}$ Cr-1 Mo, and 9 Cr), and three high chromium stainless irons (410, 430, and 446) in a Pb–Bi eutectic melt for 96 hr was studied. An attempt was made to compare the corrosion resistance of one material with that of another, rather than to determine the absolute rates of corrosion of the individual materials. From the standpoint of corrosion product accumulation in the liquid metal it was concluded that the steels containing small amounts of chromium would be more desirable container materials than those containing large amounts of chromium. However, in making a choice of materials it was decided that rapid intergranular attack followed by extensive spalling was a more important consideration than the amount of chromium or iron released to the liquid metal by the lower chromium steels, and on this basis the 2¼ Cr–1 Mo alloy steel represented the best material. (P.C.H.)

**4907** METALLURGICAL AND CHEMICAL PROBLEMS IN WATER REACTORS. E. C. W. Perryman (United Kingdom Atomic Energy Authority, Culcheth, Eng.) and J. K. Dawson. J. Brit. Nucl. Energy Soc., 1: 354-63(Oct. 1962).

An outline is presented of metallurgical and chemical problems (e.g., corrosion) involved in the design of fuel elements, structural materials, and control materials for water-cooled reactors. Attention is also given to coolant chemistry. (T.F.H.)

**4908** THE CORROSION OF PLUTONIUM. J. T. Waber (Los Alamos Scientific Lab., N. Mex.) and E. S. Wright. p.194-204 of "The Metal Plutonium." Chicago, University of Chicago, 1961. (LADC-3107)

The corrosion behavior of Pu is investigated in moist and dry air at temperatures up to 75°C and in pure $O_2$ at high temperatures. The slow oxidation by dry air is increased by water vapor, and the parabolic (diffusion-controlled) rate in dry air is changed to a linear (interface-controlled) rate in wet air. At 315 and 325°C in pure $O_2$, delays (slow initial rates) are observed in the oxidation, which are probably due to the time needed to heat the sample surface. The runs at 343 and 400°C do not exhibit these delays. (D.L.C.)

## Fabrication

*Refer also to abstracts 5589 and 5591.*

**4909** (GEAP-3891) POWDER FUEL PROCESSING BY TWO-PASS SWAGING. THE EFFECT OF PARTICLE SIZE AND DISTRIBUTION. C. M. Ryer (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Apr. 10, 1962. Contract AT(04-3)-361. 31p.

The fabrication of fuel rods by vibratory compaction of arc-fused $UO_2$ powder followed by two-pass swaging was investigated. The particle size and distribution of the powder was found to greatly influence the density of the final product. A method of broad-banding the powder mix was developed to provide for optimum utility and to limit the variables of density and rod elongation. Rods were made by this process for irradiation studies in Vallecitos Boiling Water Reactor. (auth)

**4910** (MAB-139-M(C7)) RECOMMENDED RESEARCH PROGRAMS FOR CASTING. Seventh Progress Report by the Panel on Casting and Powder Metallurgy. (National Research Council. Materials Advisory Board). Sept. 14, 1962. 41p.

It is felt that tungsten and beryllium need more basic concept work in order to achieve optimum casting usage. Molybdenum and niobium casting techniques are established, but need further refinement. Casting of steel, aluminum, magnesium, titanium, and nickel- and cobalt-base alloys is, in general, within the current state of the art or sufficiently close that anticipated growth potential will be adequate. However, casting titanium to precision standards by investment techniques and achieving the desired strength-to-density ratios for nickel- and cobalt-base alloys will require considerable metallurgical development. Each of the recommended research programs has been rated by order of importance, degree for order of difficulty, and probability of success. (R.J.S.)

**4911** (NMI-9700.3) DEVELOPMENT OF DIES FOR EXTRUSION OF COMPLEX SHAPES OF STEEL AND REFRACTORY ALLOYS. Interim Progress Report, June 15, 1962 through September 15, 1962. J. G. Hunt, R. G. Jenkins, A. M. White, and P. Loewenstein (Nuclear Metals, Inc., Concord, Mass.). Dec. 17, 1962. Contract AF 33(657)-8798. 33p.

Significant improvement in the properties of ceramic-coated metallic, metal-fiber-reinforced ceramic, and refractory intermetallic dies, for use in the extrusion of refractory metals and steels, is sought. A state-of-the-art survey was conducted by reference to reports and by visits to experimental and production extrusion facilities experienced in extruding specialty steels and refractory metals. A survey of available materials revealed a number which are potentially fabricable into improved dies. Preliminary choices of material were guided by the agreement of known or predicted properties at various temperatures with characteristics desired in the dies. An indentor device for testing coated substrates was designed and its construction started. Hot pressing furnaces for consolidating the various materials were designed, built, and tested. (auth)

**4912** (ORNL-TM-413) BRAZING OF CERAMICS. Progress Report. C. W. Fox (Oak Ridge National Lab., Tenn.). Nov. 8, 1962. Contract [W-7405-eng-26]. 20p.

Brazing alloys such as 48 Ti-48 Zr-4 Be (wt %) and 49 Ti-49 Cu-2 Be (wt %) have been found to readily flow on oxide and graphite ceramics. Two demonstration fuel element assemblies were fabricated to illustrate the usefulness of these procedures for nuclear applications. One of these assemblies contained graphite tubes and end caps which were brazed to a molybdenum hanger. The second demonstration fuel element was composed of a compartmented aluminum oxide plate to which aluminum oxide cover plates were brazed. (R.J.S.)

**4913** STEAM SINTERING OF URANIUM DIOXIDE. W. E. Baily (Westinghouse Electric Corp., Pittsburgh), J. C. Danko, H. M. Ferrari, and R. Colombo. Am. Ceram. Soc. Bull., 41: 768-72(Nov. 15, 1962).

Effects of a steam atmosphere on the sintering of uranium dioxide were investigated. Experiments were performed on two different powders at several temperatures and for varying periods of time. Dilatometric studies were conducted on the pellets during the sintering cycle. Steam sintering of $UO_2$ was found to be more effective than hydrogen sintering. Appreciable sintering occurred at temperatures as low as 750°C. The heating and cooling atmospheres were found to have negligible effects on the sintered characteristics of the specimens. (auth)

**4914** THE EFFECT OF ROLLING PARAMETERS ON THE PROPERTIES OF BERYLLIUM SHEET METAL. E. E. Weismantel (Beryllium Corp., Reading, Penna.) and Hugh L. Black. Am. Soc. Metals, Trans. Quart., 55: 685-96(Sept. 1962).

The effect of roll reduction parameters on the properties of beryllium sheet of two different chemical compositions was investigated. The effect of production history associated with breakdown and final rolling temperatures and reduction ratio is described as it affected both the metallurgical structure and the associated mechanical properties. The effects of breakdown temperature, final rolling temperature, and reduction ratio on the structure and properties of beryllium sheet were also studied. Lower rolling temperatures produced highest ultimate tensile strength, highest ductility, and finer grain structures. Slightly higher strengths were obtained with materials containing greater amounts of beryllium oxide. (auth)

**4915** GETTING THE MOST FROM PROJECTION WELDING. W. A. Owczarski (Knolls Atomic Power Lab., Schenectady, N. Y.). Machinery (N. Y.), 69: No. 2, 97-106 (Oct. 1962)

The major differences between projection and spot welding are pointed out. The design of the projections for welding and material considerations are discussed. Some applications are described. The design and properties of electrode materials are discussed in detail. Design and welding data are given for the projection welding of low-carbon steels. Finally, some features of equipment for projection welding are described. (D.L.C.)

**4916** SPINNING OF REFRACTORY ALLOYS. P. P. Crimmins and C. W. Heimlich (Aerojet-General Corp., Sacramento, Calif.). Metal Progr., 82: No. 6, 67-72(Dec. 1962).

Conventional and shear spinning are useful tools for fabricating large components of tungsten and other refractory metals. The techniques are being applied in making rocket nozzles in sizes ranging from 0.030 to 0.250 in. thick and 3 to 14 in. in dia. (auth)

**4917** BRAZING AND SOLDERING OF METALS. N. F. Lashko and S. V. Lashko-Avakyan. Translated by Adolph Wald from a publication of Mashgiz, Moscow, 1959. 416p. (OTS-60-51082; PST Cat. No. 388). $4.25(OTS)

Basic information is provided on the physical and chemical processes and structural transformations taking place during soldering of metal, as well as on the design of soldering joints, the preliminary treatment of the parts to be joined, solders (soldering alloys) and fluxes, the technology and methods of manual and mechanized soldering, and finally on soldering of various base metals and their alloys. (R.J.S.)

**4918** THE FABRICATION OF BILLETS CONTAINING PLUTONIUM FOR MTR FUEL ELEMENTS. R. E. Tate (Los Alamos Scientific Lab., N. Mex.). p.347-64 of "The Metal Plutonium." Chicago, University of Chicago, 1961. (LADC-3101)

The problems presented by the properties of Pu are discussed, and the Al–Pu system is discussed relative to the Al–U system. The fabrication of Al–10 wt % Pu for the MTR plate assembly-type fuel elements is reviewed: alloying, casting, rolling, and blanking. Equipment and safety measures for the fabrication are described. (D.L.C.)

**4919** EXTRUSION OR DRAWING OF BERYLLIUM. Graham Eric Moore (to T. I. (Group Services) Ltd.). British Patent 909,502. Oct. 31, 1962.

A protective coating of Ag is applied to Be by immersion in a dispersion of Ag in a volatile liquid. This coating prevents direct contact between the Be and the tools involved in extrusion or drawing operations. (R.J.S.)

**4920** IMPROVEMENTS IN OR RELATING TO OXIDES OF URANIUM CONTAINING NON-STOICHIOMETRIC AMOUNTS OF URANIUM AND OXYGEN. George Elliot Christie (United Kingdom Atomic Energy Authority). British Patent 909,698. Oct. 31, 1962.

A process is described for densifying and sintering uranium oxide compositions at the temperatures at which non-stoichiometric uranium oxides in the range $UO_{2.02}$ to $UO_{2.3}$ are sinterable. (R.J.S.)

**4921** IMPROVEMENTS IN OR RELATING TO A PROCESS FOR EFFECTING A WELDED AND BRAZED SEAL BETWEEN TWO MEMBERS. John Guy Purchas and Eric Brown (to United Kingdom Atomic Energy Authority). British Patent 909,725. Oct. 31, 1962.

A process is described for effecting a welded and brazed seal between members having contiguous edges to be edge-welded and contacting surfaces to be brazed. The steps are set forth of arranging the assembled members in a vacuum vessel, focusing an electron beam on the contiguous edge, moving the edges relatively to the beam to effect an edge weld, and defocusing the beam to effect a brazing operation. (R.J.S.)

**4922** IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF SINTERED URANIUM DIOXIDE. Lewis Eric Russell, John David Lawrence Harrison, and Norman Harry Brett (to United Kingdom Atomic Energy Authority). British Patent 910,517. Nov. 14, 1962.

A method is described for producing a dense sintered body of uranium dioxide or a mixture thereof with plutonium dioxide. Compacted uranium dioxide or a compacted uranium dioxide–plutonium dioxide mixture is heated to at least 1300°C in an atmosphere of carbon dioxide or carbon dioxide mixed with carbon monoxide. (R.J.S.)

## Properties and Structure

**4923** (ANL-6460) ROOM-TEMPERATURE LATTICE CONSTANTS OF ALPHA URANIUM–PLUTONIUM ALLOYS. A. F. Berndt (Argonne National Lab., Ill.). Oct. 1962. Contract W-31-109-eng-38. 26p.

A technique has been developed by which accurate lattice constants can be calculated for alpha uranium from Debye-Scherrer patterns prepared from needle specimens and has been applied to the determination of room temperature (25 ± 2°C) lattice constants of solid solutions of plutonium in alpha uranium. The uranium-plutonium alloy specimens were prepared by furnace cooling from 400°C. The values of lattice constants $a_0$ and $c_0$ were found to increase and those of $b_0$ to decrease with increasing plutonium content. The lattice constants of an alpha uranium-15 wt % plutonium alloy were found to be: $a_0 = 2.8625$ Å; $b_0 = 5.8562$ Å; $c_0 = 4.9631$ Å. (auth)

**4924** (ARF-B231-7) PILOT EVALUATION OF VANADIUM ALLOYS. Bimonthly Report No. 7, September 18, 1962–November 17, 1962. B. R. Rajala and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Dec. 14, 1962. Contract NOw 62-0101-c. 31p.

V–Nb alloys prepared as 200-gram arc-melted ingots were evaluated for fabricability and tensile properties to 2400°F. Of the high-vanadium compositions, the strongest was V-5 wt % Ti-20 wt % Nb-10 wt % Ta which had strength values of 54,000 and 15,700 psi at 2000° and 2400°F, respectively. Tensile values of the stronger alloys at the 60 wt % Nb levels were near 65,000 psi at 2000°F and near 20,000 psi at 2400°F. Strengthening of the V–Nb alloy bases was accomplished by addition of refractory metals (Ta, W), the reactive metals (Ti, Zr, Hf), and the interstitials (C, O, N). Material from the first 100-pound double consumable-electrode arc-melted ingot, a V-1 wt % Ti-60 wt % Nb composition, was distributed to the organizations participating in the data exchange program. A second 100-pound ingot, V-4 wt % Ti-20 wt % Nb-1 wt % Ti-0.075 wt % C, was triple-melted and forwarded to a commercial source for extrusion and subsequent fabrication to bar, plate, and sheet. (auth)

**4925** (DRI-2065) A STUDY OF THE SYNTHESIS AND PROPERTIES OF TRANSITION-METAL HYDRYLS. First Quarterly Progress Report, June 1, 1962—September 30, 1962. Charles B. Magee (Denver Univ. Denver Research Inst.). Oct. 15, 1962. Contract AT(11-1)-1185. 21p.

The existence of rhodium lithium hydryl compounds ($Rh_2(LiH)_8$ and $Rh(LiH)_4H$) was previously reported by J. D. Farr. A program is being carried out to synthesize the rhodium lithium hydryls and other transition metal hydryls; to determine the properties, particularly the thermal stability, of these compounds; and to investigate the type of chemical bonding exhibited by these compounds. Hydriding equipment was made ready, reaction chambers were fabricated and calibrated, and materials were procured for carrying out synthesis experiments. Some ten experiments involving the Rh-Li-H system were performed. These experiments included the reaction of LiH with Rh (4 to 1 molar ratio of LiH to Rh), $H_2$ with Li, $H_2$ with Rh, and $H_2$ with a mixture of Li and Rh (4 to 1 molar ratio). In the hydryl synthesis experiments a material was obtained which physically resembles the description of $Rh_2(LiH)_8$ given by Farr. This material is hard, black, and crystalline and has a density of about 4.3 grams/cc. In some experiments a material showing the x-ray diffraction pattern attributed to $Rh(LiH)_4H$ by Farr was obtained, but the pattern attributed to $Rh_2(LiH)_8$ was not observed. Unambiguous equilibrium hydrogen pressure versus composition isotherms were not obtained, primarily because of the effect that lithium, which had distilled from the reaction boat to cooler portions of the reaction chamber, had on the observed hydrogen pressure. (auth)

**4926** (EUR-17.f) ÉTUDE DU NICKEL COMME BARRIÈRE DE DIFFUSION ENTRE L'URANIUM ET L'ALUMINUM. (Study of Nickel as a Diffusion Barrier Between Uranium and Aluminum). F. Brossa, R. Theisen (European Atomic Energy Community); J. J. Huet, and D. Tytgat (Mol, Belgium. Centre d'Etude de l'Energie Nucléaire). May 1962. 50p.

The technological application of U—Ni—Al ternary diffusion was studied for U-metal-base nuclear elements covered with a film of Ni (as an anti-diffusion barrier and as a metallic bond) and cladded with Al. The known surface treatments for Al and U and the deposition of Ni were improved. The behavior of Ni during the solid-state reactions with U and Al at different temperatures and under various pressures was studied. By determining the composition of the various diffusion zones and establishing the diffusion laws, it is possible to calculate the thickness of the anti-diffusion barrier for the prescribed operating conditions (temperature, pressure and lifetime of a nuclear element). (auth)

**4927** (EURAEC-312) RARE GAS DIFFUSION IN SOLIDS. Final Report No. 1, July 1, 1960—August 31, 1961. (Hahn-Meitner-Institut für Kernforschung, Berlin). Apr. 17, 1962. Work Performed under United States—Euratom Joint Research and Development Program. Contract EUR/C/710/2/60. 15p.

Argon diffusion tests were carried out on potassium halides and potassium salts of aliphatic acids. Test techniques were developed for studying xenon diffusion from uranium dioxide, uranium carbides, and thorium dioxide. (R.J.S.)

**4928** (GAT-T-998) THE PRECISE AND ACCURATE DETERMINATION OF THE LATTICE PARAMETER OF TUNGSTEN USING THE LIKELIHOOD RATIO METHOD. Karl E. Beu (Goodyear Atomic Corp., Portsmouth, Ohio). Nov. 1, 1962. Contract AT(33-2)-1. 13p.

The Likelihood Ratio Method (LRM) has been used to obtain a precise and accurate value of the lattice parameter of tungsten from centroid diffractometer data. The LRM has shown that each of the six systematic error corrections used was valid. It has further shown that the angular scale correction for the (110) reflection is not quite correct, thus illustrating how the LRM is useful in pinpointing possible sources of difficulty in making systematic error corrections. The LRM has great sensitivity for detecting the valid removal of systematic errors from the Bragg angle measurements in terms of its $W_m$ and $\hat{e}_1$ test functions. (R.J.S.)

**4929** (IS-327) THE HIGH TEMPERATURE HEAT CONTENTS AND RELATED THERMODYNAMIC PROPERTIES OF LANTHANUM, PRASEODYMIUM, EUROPIUM, YTTERBIUM, AND YTTRIUM. J. R. Berg, F. H. Spedding, and A. H. Daane (Ames Lab., Ames, Iowa). July 26, 1961. Contract [W-7405-eng-82]. 35p.

The high temperature enthalpies of five rare earths were measured from 0 to 1100°C using a Bunsen ice calorimeter. The enthalpy of yttrium metal was studied from 1100 to 1675°C using a modified high temperature vacuum Bunsen calorimeter. The data were fitted to empirical equations from which the heat of transition and fusion, the heat capacity, and the related thermodynamic quantities were calculated. These results confirmed indications from other properties that europium and ytterbium metals are primarily in the divalent state. Small anomalies observed in europium and ytterbium were attributed to transitions between electronic states when some trivalent ions occur in these metals. The entropy of the fcc-bcc transition for ytterbium was found to be approximately two-thirds that of the other rare-earth metals for which a close-packed to body-centered cubic transformation was observed. (auth)

**4930** (NMI-7010) THE ALUMINUM—LITHIUM PHASE DIAGRAM. E. D. Levine and E. J. Rapperport (Nuclear Metals, Inc., Concord, Mass.). Feb. 6, 1962. Contract AT(30-1)-1565. 49p.

The boundaries of the ($\alpha + \beta$) field in the aluminum-lithium system were determined between 150 and 550°C by quantitative metallography and lattice parameter measurements. The solubility of lithium in aluminum decreases from 12.0 at. % Li at 550°C to 5.5 at. % Li at 150°C. $\beta$-Al-Li is saturated with aluminum at 45.8 at. % Li. (auth)

**4931** (NP-12306) HIGH TEMPERATURE CERAMIC STRUCTURES. Final Summary Report, November 1, 1961 to October 31, 1962. N. E. Poulos, S. R. Elkins, C. A. Murphy, and J. D. Walton (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Oct. 31, 1962. Contract NOrd-15701. 115p.

A procedure was developed for pressure casting radomes from fused silica slip. The effect of pressure casting on the slip properties of the drained slip was determined. A furnace to facilitate firing large radome shapes was designed and constructed. The effects on the physical properties of vibrated and nonvibrated fused silica pressure-cast at various pressures were investigated. A pressure casting rate study was conducted to investigate the possibility of using the Kozeny equation for prediction of cast wall thickness and to determine influences on the casting rate. Several radome tip configurations were flame glazed in preparation for rain erosion tests. Evaluation of the effect of flame glazing the surface of slip-cast fused silica on its electrical properties was initiated. Development of a fused silica slip which has a green modulus of rupture in the range of 2000 to 3000 psi was pursued. The transverse green strength was increased by impregnating the bars in an organo-silicate solution for 24 hours and gelling with sulfuric acid followed by two-stage drying. Organo-silicate impregnation was employed to improve the fired strength of slip-cast fused silica. Aluminum chloride impregnating methods were continued to determine the method that would increase the strength and decrease the porosity of slip-cast fused silica. The effects of surface skin removal were studied in conjunction with the aluminum chloride studies. Attempts were made to improve the annealing procedure. Also, the effect of the flame glazed surface on the strength of slip-cast fused silica was investigated. The strength results indicated that there is very little difference in strength of the standard sample broken with its curved surface up or down. An arc-plasma flame glazing device was designed and constructed to totally flame glaze the exterior surfaces of full-sized slip-cast fused silica radomes. Studies were conducted using this device to establish flame glazing parameters for flame glazing a radome. The possibility of substituting the less expensive oxy-acetylene torch for the arc-plasma torch in flame glazing was investigated. (R.J.S.)

**4932** (TID-17372) TENSILE PROPERTIES OF ZIRCALOY WITH ORIENTED HYDRIDES. R. P. Marshall and M. R. Louthan, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [Nov. 1962]. Contract AT(07-2)-1. 15p.

Room temperature tensile tests were conducted to determine the effect of hydrogen content and hydride orientation on the tensile properties of Zircaloy-4 tubing. It was found that hydride platelets oriented nearly perpendicular to the deforming tensile stress caused large reductions in strength and ductility, whereas the platelets oriented nearly parallel to deforming stress had little effect on the tensile properties. All specimens containing more than 50 ppm hydrogen as "normal" (perpendicular) hydrides exhibited no macroscopic ductility, irrespective of the total hydrogen content. (auth)

**4933** (WADD-TR-60-463(Pt.II)) THE VAPORIZATION AND PHYSICAL PROPERTIES OF CERTAIN REFRACTORIES. PART II. EXPERIMENTAL STUDIES. A. A. Hasapis, A. J. Melveger, M. B. Panish, L. Reif, and C. L. Rosen (Avco Corp. Research and Advanced Development Div., Wilmington, Mass.). July 1961. Contract AF33(616)-6840. 85p.

The vapor pressure-temperature relationships for iridium, rhodium, ruthenium, iridium plus carbon, alumina, thoria, and hafnia were studied by simple effusion and mass spectrometric methods. Vapor phase species were identified. The vapor pressure data and derived heats of vaporization and reaction are presented. The vaporization modes of the rare earth sesquioxides were studied mass spectroscopically and data are given which demonstrate that the mode of vaporization of these materials is strongly dependent upon the number of electrons in the 4f shell of the rare earth metal. Continuously monitored effusion experiments conducted on the Mo–Si system yielded the following heats of dissociation in kcal/gm atom Si at 298°K: Liquid-$MoSi_2$, 117.8; $MoSi_2$–$Mo_5Si_3$, 121.5; $Mo_5Si_3$–$Mo_3Si$, 128.3; $Mo_3Si$–Mo, 132.9. Continuously monitored experiments on the W–Si system yielded the following approximate dissociation pressures in atms. at 1765°K: liquid-$WSi_2$, $3.5 \times 10^{-4}$; $WSi_2$–$W_3Si_2$, $2.6 \times 10^{-4}$; $W_3Si_2$–W, $1.7 \times 10^{-6}$. The surface tensions of silica and silica plus 1% oxide additives and zirconium plus uranium have been measured by a sessile drop technique. The viscosities of alumina, zirconium plus uranium, pure silica, silica plus 1% $V_2O_5$, silica plus 1% CoO, and silica plus 1% $Al_2O_3$, have been determined. (auth)

**4934** (AEC-tr-5534) THE MODULUS OF ELASTICITY OF METALLIC ALLOYS. M. L. Guillet. Translated by A. L. Monks (Oak Ridge National Lab., Tenn.) from Rev. Met. (Paris), No. 12, 497-508(1939). 21p.

The characteristics of the modulus of elasticity of metallic alloys are discussed. Methods for measuring this coefficient are described. Direct measurements and indirect measurements are discussed. The pendular method of Le Rolland and Sorin is outlined and the equipment described. When two identical pendulums are suspended to a plateau supported by a small test sample, the sustained oscillations are added to the natural pendulum oscillations. Because of sample flexibility, the frequency of the two oscillations differs to a lower degree the more rigid the sample is. Therefore the beat duration is longer, the higher the samples' modulus of elasticity. (M.C.G.)

**4935** (AEC-tr-5545) PYROPHOROUS ALLOYS. H. Nowotny, Helga Auer-Welsbach, and A. Wittmann. Translated from Oesterr. Chemiker-Z., 60: 12-16(1959). 15p.

The structure and structure-chemical relations in Auer metal (technical cerium-iron alloys) were studied. The essential crystal types could be identified by an x-ray method. Cerium-free ignition alloys based on titanium and zirconium are discussed with respect to their pyrophorous phases. The role of oxygen in frictionally pyrophorous alloys and their oxidation reaction mechanisms are described. (auth)

**4936** THORIUM–VANADIUM PHASE DIAGRAM. P. E. Palmer, O. D. McMasters, and W. L. Larsen (Iowa State Univ., Ames). Am. Soc. Metals, Trans. Quart., 55: 301-6(June 1962). (IS-361)

The phase diagram of the Th–V system was determined by thermal, electrical resistance, x-ray, and metallographic methods. The diagram is simple eutectic in form with a eutectoid reaction associated with the Th $\alpha$-$\beta$ transformation. The eutectic point was established at 1435° ± 10°C (2615°F) and 5.0 ± 0.5 wt % V. The eutectoid reaction occurs at 1345° ± 10°C (2453°F) and less than 0.1 wt % V. The solubility of V in Th is less than 0.4 wt % at the eutectic temperature. The solubility of Th in V was determined to be less than 0.4 wt % at 1390°C (2534°F). (auth)

**4937** SURFACE DAMAGE IN BERYLLIUM. M. I. Jacobson, F. M. Almeter, and E. C. Burke (Lockheed Missiles and Space Co., Palo Alto, Calif.). Am. Soc. Metals, Trans. Quart., 55: 492-504(Sept. 1962).

The nature and effects of surface damage in hot-pressed, hot-rolled, and hot-upset beryllium sheet were investigated. Metallographic examination showed that surface damage in as-received sheet and in sheet with ground surfaces consisted of twins and cracks. Annealing to remove twins and relieve residual stresses resulted in sharp increases in ductility for all types of sheet, as indicated by tensile, bend, and impact tests. In some cases, etching after annealing produced further increases in properties. Electron diffraction studies revealed the presence of a thin layer of basal planes oriented parallel to the surface of ground samples. The poor ductility in machined beryllium was attributed to highly twinned areas acting as the favored loci for crack formation. Cracks did not appear to be as detrimental as twins. (auth)

**4938** HIGH CONDUCTIVITY Cu–Zr–As ALLOYS. Matti J. Saarivirta (U. S. Metals Refining Co., Carteret, N. J.). Am. Soc. Metals, Trans. Quart., 55: 531-41(Sept. 1962).

It is shown that proper addition of arsenic to high-conductivity Cu–Zr alloys improves both strength and electrical conductivity and retards grain growth. The alloy containing Cu–0.50% Zr–0.25% As exhibits the desirable combination of properties: 73000 psi tensile strength, over 10% elongation, and 90% IACS conductivity. (auth)

**4939** ZIRCONIUM–HYDROGEN PHASE SYSTEM. Richard L. Beck (Univ. of Denver). Am. Soc. Metals, Trans. Quart., 55: 542-55(Sept. 1962).

The Zr–H binary system was investigated principally by use of pressure composition isotherms, room-temperature and high-temperature x-ray diffraction, and metallography. In addition to the two zirconium allotropes (alpha and beta), and two stable hydride phases (delta and epsilon), a metastable hydride phase (gamma) was positively identified. Information regarding transformation mechanisms, reaction kinetics, and crystal structures are presented for all three of the hydride phases. The composition limits of the phases are described in detail, and reasons are presented which account for many of the variations reported previously. (auth)

**4940** THERMOPHYSICAL PROPERTIES OF ZIRCONIUM HYDRIDE. Richard L. Beck (Univ. of Denver). Am. Soc. Metals, Trans. Quart., 55: 556-64(Sept. 1962).

Thermal conductivity values were determined for three Zr–H alloys containing 60.0, 56.6, and 45.3 at. % H. A definite negative coefficient of conductivity was observed for the delta hydride (60.0 at. % H) over the test range (300 to 720°C). The observed conductivities at the lower hydrogen levels are discussed in terms of the phases present. Dilatometric data for four Zr–H alloys ranging from 41.0 to 64.7 at. % H are presented. The average expansion coefficient for delta phase (60.7 at. % H) from 200 to 850°C was shown to be $14.2 \times 10^{-6}$ per C. Reasons are given to explain some of the grossly contradictory expansivity data which have appeared in the literature. Heat capacity data from drop calorimeter tests are presented for three Zr–H alloys containing 64.0, 57.1, and 50.2 at. % H. Specific heat curves were obtained from the data for delta phase (57.1 at. % H) in the range from 500 to 750°C and for epsilon phase (64.0 at. % H) in the range from 200 to 625°C. In addition to the experimental data, a technique is described for producing massive test specimens which are free of cracks and of uniform hydrogen content. (auth)

**4941** OBSERVATIONS ON THE BEHAVIOR OF HYDROGEN IN BERYLLIUM. C. E. Ells and W. Evans (Atomic Energy of Canada Ltd., Chalk River, Ont.). Am. Soc. Metals, Trans. Quart., 55: 744-8(Sept. 1962).

A study was made of agglomerates formed from hydrogen injected into beryllium by cyclotron proton irradiation. Samples of zone melted, cast, hot pressed, and extruded beryllium were used. In general, the agglomerates were detected in the cast materials after a minimum post irradiation heat treatment of 1 hr at 300°C. For fine-grained materials of high oxide content, however, agglomerates were only revealed after heating for 1 hr at temperatures exceeding 500°C. The structure obtained in large-grained materials after heating for 1 hr in the temperature range 300 to 400°C consisted of agglomerates at the upper and lower edges of the hydrogen-containing layer. It was assumed that the agglomerates are hydrogen-filled bubbles. Thus the behavior of hydrogen in beryllium is seen to be consistent with the behavior of other gas-metal systems in which the gas is only slightly soluble. (P.C.H.)

**4942** THE THERMAL CONDUCTIVITY OF INOR-8 BETWEEN 100 AND 800 C. D. L. McElroy, T. G. Godfrey, and T. G. Kollie (Oak Ridge National Lab., Tenn.). Am. Soc. Metals, Trans. Quart., 55: 749-51(Sept. 1962).

The thermal conductivity of INOR-8 was measured in a radial heat flow apparatus between 100 and 800°C. The results indicated that the thermal conductivity of INOR-8 increases linearly with temperature to about 450°C, where an inflection occurs; this is followed by another linear portion with a slightly greater slope. At about 680°C, a second larger increase of about 10% was observed, and this was followed by what appeared to be another linear portion. No direct explanation for the behavior is given. The study showed that thermal conductivity measurements are sensitive to internal changes as are specific heat and thermal expansion measurements. A description of the apparatus used is given. (P.C.H.)

**4943** SURFACE TENSION STUDIES OF LIQUID ZIRCONIUM–RARE EARTH ALLOYS. Francis Shunk and Arthur A. Burr (Rensselaer Polytechnic Inst., Troy, N. Y.). Am. Soc. Metals, Trans. Quart., 55: 786-9(Sept. 1962).

Measurements of surface tension of selected zirconium–rare earth alloys were made using a modified drop weight technique. Variations of the surface tension of the liquid alloy with increasing alloy content are reported for alloys of zirconium with Y, Nd, Er, Ho, and Dy. Whereas the first four of the solutes decreased the surface tension from that of pure Zr, Dy raised it. It is shown that the order of the effects follows the Mott number for the alloys. This is believed to indicate a tendency for bond formation in the alloys. (auth)

**4944** THE VISCOSITY AND DENSITY OF MOLTEN PLUTONIUM METAL AND A PLUTONIUM–CERIUM–COBALT EUTECTIC ALLOY. L. V. Jones, Donald Ofte, W. G. Rohr, and L. J. Wittenberg (Mound Lab., Miamisburg, Ohio). Am. Soc. Metals, Trans. Quart., 55: 819-25(Sept. 1962).

The absolute viscosities of molten plutonium metal and a molten plutonium–cerium–cobalt eutectic alloy were measured in an oscillating cup viscosimeter. The density of the molten plutonium–cerium–cobalt eutectic alloy was determined by a pycnometric method. Straight-line relationships were exhibited when the logarithms of the viscosities were plotted as a function of reciprocal absolute temperatures. The equations of the lines generated for the metals investigated are: $\mathrm{Pu}_{(645-950\ \mathrm{C})}$ — $\log_{10}\eta = 0.672999$ (1/T) 0.037 and $\mathrm{Pu{-}Ce{-}Co}_{(446-801\ \mathrm{C})}$ — $\log_{10}\eta = 1.038999$ (1/T) 0.270, where: $\eta$ = centipoise and $T = {}^{\circ}\mathrm{K} \times 10^{-3}$. The equation of the line relating the density of the Pu–Ce–Co eutectic alloy with temperature is: $\mathrm{Pu{-}Ce{-}Co}_{(475-750\ \mathrm{C})}$ — $\rho = 9.082 - 2.31 \times 10^{-4}\ T$, where: $\rho$ = density (g/cc) = °C. (auth)

**4945** VISCOSITY AND ATOMIC MOBILITY IN LIQUID METALS. Harry J. Saxton and Oleg D. Sherby (Stanford Univ., Calif.). Am. Soc. Metals, Trans. Quart., 55: 826-43(Sept. 1962).

It was shown that the viscosity of liquid metals can be quantitatively related to the atomic mobility characteristics. Sutherland's theory of viscosity appears to best correlate with the experimental data. Analysis of the viscosity and diffusivity data for 22 different elements suggested that atomic mobility in liquids occurs by a thermal activation process and obeys the relation $D_L = (Do)_L e^{-Q/RT}$. The activation energy for diffusion is accurately described by Q = RKTm where R = gas constant, Tm = absolute melting temperature, and K = 3 for typical metals and 2.75 for semimetals. $(Do)_L$ appears to be a function of the former crystal structure and the atomic mass, M, and can be given by $(Do)_L = C/\sqrt{M}$. The constant C is twice as large for former bcc metals as for former close-packed metals and is a function of coordination number for semimetals (decreases with increasing coordination number). The experimental values of the ratio $Do_L/Do_S$ for typical metals can be accurately predicted by the Zener relation for Do, provided it is assumed that diffusion occurs by an atom-vacancy exchange process in solids and by a pseudo-four-atom-ring mechanism in liquids. (auth)

**4946** QUANTITATIVE DETERMINATION OF ELECTRIC MOBILITIES IN LIQUID BISMUTH ALLOYS ABOVE ROOM TEMPERATURE. John D. Verhoeven and Edward E. Hucke (Univ. of Michigan, Ann Arbor). Am. Soc. Metals, Trans. Quart., 55: 866-76(Sept. 1962).

An experimental method for quantitatively determining the electric mobility (or transport number) of solutes in liquid metal systems is described. Experimental results on the mobility of Cu, Ni, Mg, Zr, Pd, U in liquid bismuth at approximately 500°C are presented. Data on the variation of the mobility with addition of a second solute and with temperature are also presented. (auth)

**4947** VAPOR PRESSURE OF ALKALI METALS. RUBIDIUM, CESIUM, AND SODIUM–POTASSIUM ALLOY (NaK) UP TO 100 PSI. Charles F. Bonilla, Dulari L. Sawhney, and Munzer M. Makansi (Columbia Univ., New York). Am. Soc. Metals, Trans. Quart., 55: 877-90(Sept. 1962).

The vapor pressures of high-purity cesium, rubidium, and NaK (sodium–potassium alloy) of 30.6 wt % sodium were measured from roughly 1 to 100 lb psi abs. The method employed boiling under argon, in a small capsule to ensure temperature uniformity. Recent independent results by others on sodium, in close agreement with earlier sodium data obtained with the apparatus, demonstrated its reliability. Its reproducibility was also demonstrated by the close agreement of results with two different charges of cesium, and by the low standard errors of the data. The vapor pressures of cesium and rubidium were found to be about 20% higher than the values recently computed by others, and up to about 10% higher than results reported in larger boilers from other laboratories. The corrected normal boiling points for the pure metals were found to be: Cs, 666.25°C; Rb, 685.73°C. The vapor pressure of NaK was found to agree with Raoult's Law, well within experimental uncertainties. Analysis indicated that log P versus 1/T fitted the vapor pressure data very well over the experimental range, and that an additional log T term was not justifiable statistically. (auth)

**4948** TRACER EVIDENCE OF STRUCTURE HEREDITY BETWEEN $\beta$ AND $\alpha$ PHASES OF COBALT. Marc Aucouturier and Paul Lacombe (Ecole des Mines, Paris). Compt. Rend., 255: 1110-12(Aug. 6, 1962). (In French)

The comparison of the grain-boundary lattice of the face-centered cubic $\beta$ phase of Co detected by intergranular diffusion of $Fe^{59}$ and of the boundary lattice of the hexagonal compact $\alpha$ phase after anneal on the same sample gives a direct proof of the structure heredity between the $\alpha$ and $\beta$ boundaries during the $\beta \rightarrow \alpha$ transformation. (tr-auth)

**4949** DYNAMIC YIELD BEHAVIOR OF EXPLOSIVELY LOADED METALS DETERMINED BY A QUARTZ TRANSDUCER TECHNIQUE. O. E. Jones, F. W. Neilson, and W. B. Benedick (Sandia Corp., Albuquerque, N. Mex.). J. Appl. Phys., 33: 3224-32(Nov. 1962). (TID-15803; SCDC-2518)

Explosively generated plane waves were passed through plates of duraluminum, iron, and steels of various compositions and heat treatments. X-cut quartz disks of large diameter-to-thickness ratios (≥5) were used to obtain continuous stress-time profiles of elastic-plastic wave structures associated with yielding. For times less than wave transit time through the disk, the short-circuit current output is directly proportional to the specimen-to-quartz interface stress up to 21 kbar. The incident wave profile in the specimen is then determined from the interface stress-time profile on the basis of an assumed model. Advantages of the technique are excellent time resolution, high sensitivity, and relative simplicity of use. The profiles for duraluminum, normalized SAE 1018 steel, and normalized Armco iron exhibit a relatively slow rise to the yield stress, subsequent stress relaxation, except in duraluminum, and then a gradual rising transition into the plastic wave. In comparison, SAE 4340 and other tool steel profiles exhibit a faster initial rise, no stress relaxation, and a steeper transition into the plastic wave. The dynamic yield stress in the tool steels increases with Rockwell hardness, and the separation between the elastic and plastic wavefronts decreases. In general, as the specimen thickness is increased, the dynamic yield stress decreases and the initial rise time increases. (auth)

**4950** FUSION ENERGIES OF $60BeO-40CaO$, $48CaO-52Al_2O_3$, $75CaO-25B_2O_3$, AND $80BeO-20Li_2O$. Homer H. Glascock, Jr. (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 33: 3296-8(Nov. 1962).

The fusion energies of several oxide mixtures were obtained by measuring the total radiant energy emitted during the solidification period. Values obtained for $60BeO-40CaO$, $48CaO-52Al_2O_3$, $75CaO-25B_2O_3$, and $80BeO-20Li_2O$ (mole %) were, respectively, 200, 85, 160, and 110 cal/g. (auth)

**4951** ELECTRICAL RESISTIVITY OF DILUTE ALLOYS OF MAGNESIUM AND NEODYMIUM. K. B. Das and A. N. Gerritsen (Purdue Univ., Lafayette, Ind.). J. Appl. Phys., 33: 3301-4(Nov. 1962).

The electrical resistivity of magnesium at room temperature was found to increase by $1.47 \pm 0.37\ \mu\Omega$ cm per atomic percent addition of neodymium. The additional resistivity is strongly temperature dependent between 77 and 373°K. In the temperature range 273 to 373°K the temperature dependence of the additional resistivity can be characterized by a temperature coefficient of the order $-2 \times 10^{-3}\ deg^{-1}$. (auth)

**4952** DEPOLARIZED COMPONENTS OF LIGHT SCATTERED BY GLASSES. III. SCATTERING FROM GENERAL STRAIN SYSTEMS, WITH APPLICATIONS TO NEUTRON-DAMAGED VITREOUS SILICA. Martin Goldstein (Ford Motor Co., Dearborn, Mich.). J. Appl. Phys., 33: 3377-82(Nov. 1962).

The influence of elastic strains, such as will arise around regions in a glass that have undergone an arbitrary volume expansion, on the components of scattered light of various polarizations is calculated. The results show that the effect of strains on the scattered intensities can be experimentally separated from the influence of size and shape of the scattering regions. Data on scattering from neutron-damaged vitreous silica are analyzed. The strain scattering is well described by assigning a reasonable value to an optical parameter that appears in the theory. Examination of that component of scattered light associated with the size and shape of the damaged regions reveals some peculiarities perhaps explicable in terms of a wide separation of damaged regions produced by a single primary recoil atom. (auth)

**4953** AN UPPER BOUND ESTIMATE FOR THE INTERPHASE SURFACE ENERGY PARAMETER OF SUPER-

CONDUCTING LEAD AT 4.2°K. Ronald B. Goldner (Purdue Univ., Lafayette, Ind.). J. Appl. Phys., 33: 3383 (Nov. 1962).

The Cochran-Kaeser intermediate state model was fitted to experimental results obtained for a transverse lead cylinder in the intermediate state. From the fit, the interphase surface energy parameter for lead at 4.2°K was estimated to be $\lesssim 1.2 \times 10^{-6}$ cm. The experiments involved the mapping of the magnetic field within a lead cylindrical crystal that was placed in a uniform magnetic field applied transverse to the longitudinal axis of the cylinder. (W.D.M.)

**4954** RECRYSTALLIZED MICROSTRUCTURES OF PYROLYTIC GRAPHITE. Aram Tarpinian (Watertown Arsenal Labs., Mass.). J. Appl. Phys., 33: 3386(Nov. 1962).

The effects of high-temperature annealing (>2000°C) on the crystal structure, crystallite size, and texture of carbons have been extensively studied. Electron microscope observations of annealed pyrolytic graphite microstructures are presented. Cleavage surfaces of annealed pyrolytic graphite were examined both in the as-cleaved and etched condition. (W.D.M.)

**4955** DEPARTURES FROM VEGARD'S LAW. K. A. Gschneidner, Jr. (Los Alamos Scientific Lab., N. Mex.) and G. H. Vineyard. J. Appl. Phys., 33: 3444-50(Dec. 1962). (LADC-5406)

A method based on second-order elasticity is developed to predict departures from Vegard's law, in binary alloy systems in which the end members have similar outer-electronic structures. This method is found to be successful in predicting the correct sign and order of magnitude of the deviation in 28 of 44 binary systems. (auth)

**4956** ELECTRON MICROSCOPY OF GRAPHITE CONTAINING BORON. G. R. Hennig (Argonne National Lab., Ill.). J. Appl. Phys., 34: 237-8(Jan. 1963). (TID-16618)

Boron is the only substance which appears to diffuse substitutionally in graphite. Diffusion of boron causes considerable lattice distortion in graphite presumably by changing the lattice constants, this results in strong twinning in regions of large concentration gradients. To determine whether this lattice strain could produce dislocation loops, boronated graphite was examined in the electron microscope. (W.D.M.)

**4957** LUBRICANTS FOR NUCLEAR REACTORS. P. E. B. Vaile (Mobil Oil Co. Ltd., Coryton, Essex, Eng.). J. Brit. Nucl. Energy Soc., 1: 374-94(Oct. 1962).

The range of operating conditions lubricants are expected to encounter in different reactors is described, with particular emphasis on the $CO_2$-cooled, graphite-moderated reactor. Nuclear lubricant requirements proposed by the UKAEA to cater for many applications are also discussed. With this information it is possible to assess realistically the types of test facility necessary for the evaluation of nuclear lubricants. Such test facilities are described. They include irradiation sources, a test rig for running under irradiation conditions, various test rigs to simulate reactor operating conditions for testing products both before and after static irradiation, and other specialized equipment. The effect of radiation on both conventional and nuclear lubricants is described and the use of 'anti-rads' illustrated. Attention is drawn to other desirable properties of nuclear lubricants such as temperature stability, low volatility, and compatibility with reactor and fuel-can materials. (auth)

**4958** THE COLLAPSE OF TUBES OF URANIUM AND SILICON CARBIDE. W. S. Blackburn (C. A. Parsons and Co. Ltd., Newcastle-upon-Tyne, Eng.). J. Nucl. Energy, Pt. A and B, 16: 391-3(Aug. 1962). (In English)

The deformation is considered which occurs when a long hollow cylinder of silicon carbide surrounded by a concentric cylinder of uranium is cooled under pressure. To avoid collapse of such a cylinder, its dimensions must be suitably chosen and so maximum values of the inner radius of the silicon carbide tube are calculated for various values of the other radii, the temperatures, and the maximum stress permissible in the ceramic. If the silicon carbide is replaced by graphite and the cylinders cooled through more than 50°C, no value of the inner radius could be found for which the compressive stress was less than the maximum permissible value. (auth)

**4959** A STUDY OF THE MAGNETIC PROPERTIES OF THE $FeTiO_3-\alpha Fe_2O_3$ SYSTEM BY NEUTRON DIFFRACTION AND THE MÖSSBAUER EFFECT. G. Shirane, D. E. Cox, W. J. Takei, and S. L. Ruby (Westinghouse Central Labs., Pittsburgh). J. Phys. Soc. Japan, 17: 1598-1611(Oct. 1962).

The solid solutions $(1-x)FeTiO_3-xFe_2O_3$ exhibit strong ferrimagnetic moments in the composition range $0.1 < x < 0.6$. In this region cation ordering is thought to occur such that the $Fe^{2+}$ and $Ti^{4+}$ ions occupy alternate (111) layers, thus forming sublattices $A[xFe^{3+}, (1-x)Fe^{2+}]$ and $B[xFe^{3+}, (1-x)Ti^{4+}]$. A neutron diffraction study shows that at least 95% of the Ti ions are located on the B layer but that they are not ordered within the layer. The temperature dependence of the magnetic intensities of a number of ferrimagnetic phases reveals that both sublattice moments, at zero magnetic field, fall considerably short of the theoretical values. In addition, Mössbauer patterns indicate that paramagnetic behavior persists over a rather wide temperature range below the Néel temperatures of solid solutions in which $x = 0.21$ and $x = 0.33$. These results are interpreted as a consequence of inhomogeneity in the magnetic structure, due to competing interactions as a result of the Ti ions being disordered within the layer. The center shift and quadrupole splitting for $FeTiO_3$ were measured over a wide temperature range. By using these results, the Mössbauer absorption by solid solutions above their Néel points can be interpreted as a superposition of the absorption peaks of $Fe^{2+}$ and $Fe^{3+}$. (auth)

**4960** DIELECTRIC CONSTANT OF STRONTIUM TITANATE AT LOW TEMPERATURES. Etsuro Sawaguchi, Atsushi Kikuchi, and Yōichi Kodera (Sony Corp., Yokohama, Japan). J. Phys. Soc. Japan, 17: 1666-7(Oct. 1962).

It has been reported that $SrTiO_3$ becomes ferroelectric below about 50°K. When $SrTiO_3$ is compared with well known ferroelectrics such as $BaTiO_3$, remarkable contrasts are found in their dielectric properties. The dielectric constants are examined in three directions: [110], [111], and [100]. (W.D.M.)

**4961** MAGNETOSTRICTION OF SINGLE CRYSTALS OF GADOLINIUM. R. M. Bozorth and Tokuo Wakiyama (Tokyo Univ.). J. Phys. Soc. Japan, 17: 1669-70(Oct. 1962).

Measurements were made with strain gages of the magnetostriction of gadolinium single crystals. The four constants necessary for a description of a hexagonal crystal were evaluated over the temperature range of 4°K to above the Curie point, using fields up to 30 kOe. The forced magnetostriction was determined by measuring the deformation ($\lambda$) as the field was changed from 10 to 20 kOe. The effect of magnetocaloric heating was observed but the measurements of $\lambda$ were made at constant temperature. (W.D.M.)

**4962** THE ANOMALOUS THERMAL EXPANSION OF SINGLE CRYSTALS OF GADOLINIUM. Tokuo Wakiyama and R. M. Bozorth (Tokyo Univ.). J. Phys. Soc. Japan, 17: 1670-1(Oct. 1962).

Previous measurements of forced magnetostriction in gadolinium single crystals have indicated that there should be a large anomaly in the thermal expansion along the hexagonal c axis, and a smaller anomaly of opposite sign in a direction perpendicular to the axis. Measurements of thermal expansion are reported which confirm these expectations and show that parallel to c there is an unusually large discontinuity at the Curie point and a large contraction over a considerable temperature range. (W.D.M.)

**4963** A TERNARY SYSTEM $PbO-TiO_2-ZrO_2$. Takura Ikeda, Tatsuya Okano, and Masayuki Watanabe (Nippon Telegraph and Telephone Public Corp., Tokyo). Japan. J. Appl. Phys., 1: 218-22(Oct. 1962). (In English)

In a ternary system $PbO-TiO_2-ZrO_2$, specimens of various compositions are prepared by solid state reactions and analyzed by x-ray-diffraction method. A reaction diagram of this system is proposed. Some compounds $ZrTiO_4$, $PbTiO_3$, $PbZrO_3$ and solid solutions $Pb(Ti-Zr)O_3$ were early known, and no other compounds are found here. Single phases of perovskite-type structure extend over wider ranges around $Pb(Ti-Zr)O_3$ than expected. Some ceramic specimens among them belonging to these phases are examined as to their dielectric and piezoelectric properties. (auth)

**4964** COATING LARGE REFRACTORY METAL PARTS. J. C. Withers and H. M. Childers. Mater. Design Eng., 56: No. 7, 120-2(Dec. 1962).

The fluidized bed process is used to deposit mixtures of Si, W, B, and other oxidation-resistant coatings. A halogen produced by a generator reacts with particles of metallic compound suspended in a hot fluidized bed by flow of inert carrier gas. The metal halide formed decomposes, depositing pure metal on the refractory part where it diffuses to form a tightly adhering coating. (R.J.S.)

**4965** BEHAVIOR OF SUPERALLOYS UNDER COMBINED STRESS AT ELEVATED TEMPERATURES. F. H. Vitovec (Univ. of Wisconsin, Madison). Machine Design, 34: No. 11, 157-8; 160; 163-4(May 10, 1962).

The effects of combined alternating and static stress on heat-resistant alloys are studied generally by reviewing data of groups of alloys and observing common trends. The alloys studied are Udimet-500, Hastelloy R-235, GMR-235, and Inconel 713 C. Stress-range diagrams are given for unnotched and notched specimens at 100-hr failure. The effects of temperature are shown on dimensionless plots of the strength values. The effects of number of cycles to failure and temperature on the effective stress concentration factor are also shown. The effects of alternating stress on the creep rate are shown for Waspalloy, S-816, and 16-25-6 as well as for the above alloys. (D.L.C.)

**4966** FERROMAGNETISM AND ANTIFERROMAGNETISM IN NON-FERROUS METALS AND ALLOYS. J. Crangle (Univ. of Sheffield, Eng.). Met. Rev., 7: 133-74(1962).

The theory and nature of magnetism in elements are discussed briefly. A literature review is presented of the work published in 1951 to 1961 on antiferromagnetism and ferromagnetism in elements other than Ni, Co, and Fe, and in their alloys and intermetallic compounds. The review covers the elements in a sequence based on the Periodic Table: first transition series, Pt- and Pd-group metals, rare-earth metals, and actinides. (D.L.C.)

**4967** A DISPERSION-STRENGTHENED NICKEL ALLOY. Fred J. Anders, Jr., Guy B. Alexander, and William S. Wartel (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). Metal Progr., 82: No. 6, 88-91; 118; 120; 122(Dec. 1962).

A new Ni alloy, containing 2% thoria as an insoluble second phase, offers high-temperature stability and useful mechanical properties virtually to the melting point of the base metal. It is easy to fabricate and has a wide forging range. (auth)

**4968** THE NEW GRAPHITES—VERSATILE ENGINEERING MATERIALS. C. E. Ford, R. M. Bushong, and R. S. Stroup (Union Carbide Corp., New York). Metal Progr., 82: No. 6, 101-7(Dec. 1962).

New graphites, including composite materials based on graphite, are stronger, tougher, less permeable, and more resistant to oxidation. (auth)

**4969** HIGH-TEMPERATURE MATERIALS FOR NUCLEAR APPLICATIONS. [PART I]. J. F. Schumar and M. T. Simnad (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Metal Progr., 82: No. 6, 147-A; 148; 150; 152; 156; 166; 168-70; 172(Dec. 1962).

Control and structural materials are discussed regarding their applications in advanced high-temperature reactors. In advanced reactors and rockets, such materials must withstand stresses at elevated temperatures, prolonged exposure to radiation, and coolant impurities. (R.J.S.)

**4970** THE DEFORMATION OF BERYLLIUM UNDER COMPLEX STRESSING. W. Munro and N. A. Hill (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Metallurgia, 66: 105-10(Sept. 1962).

The results of hot and cold bend tests on beryllium sheet and of deformation of beryllium tubes by the application of internal and external pressure, show that under complex stressing beryllium can show considerable ductility at elevated temperatures. There is a large scatter in tube properties at 620°C, the diametral expansions ranging from 0.2 to 11% and times to failure from 1 to 220 minutes under a pressure of 1,000 lb/in.$^2$. The scatter within each tube is less than the overall scatter, but is great enough to mask any differences between tubes produced by various fabrication techniques. (auth)

**4971** CAVITATION AND EROSION DAMAGE AND DAMAGE PARTICLE-SIZE MEASUREMENTS WITH RADIOISOTOPES. William J. Walsh and Frederick G. Hammitt (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng., 14: 217-23(Nov. 1962).

A radiotracer technique has been developed for the continuous measurement of cavitation damage in a closed-loop venturi facility and used to determine the damage rate of type 302 stainless steel in a cavitation field as a function of time. The size of particles removed from the test specimens was measured using a radiotracer sieving method. It is believed that these techniques have broad application in the field of cavitation and erosion studies. The measurements obtained are unique in providing an accurate damage rate measurement as a function of time for the initial stages of damage, as well as yielding an indication of particle size. The wear rates measured ranged from 0.15 mg/hr to 0.001 mg/hr and the particle diameters were predominantly between 0.5 and 3 mils. (auth)

**4972** URANIUM POWDER IGNITION STUDIES. Marvin Tetenbaum, Larry Mishler, and Glenn Schnizlein (Argonne National Lab., Ill.). Nucl. Sci. Eng., 14: 230-8 (Nov. 1962).

Because ignition temperature is not an intrinsic property of a substance, the investigation was undertaken to measure the ignition behavior of uranium powder under well-defined boundary conditions such that quantitative predictions are possible. The ignition behavior of uranium powder has been found to be dependent on specific area of powder fraction, rate of heating, and geometry of sample. For a given mesh size powder and heating rate, constant limiting ignition temperature values are obtained practically independent of container size, when the powder bed exceeds a critical height. Critical height values are found to increase with particle size of powder; for a given particle size powder, critical height values decrease with heating rate. On the basis of the Frank-Kamenetskii theory of thermal explosions, when used in a restricted manner, limiting ignition temperature values for uranium powder can be estimated using critical height values as the significant geometrical dimension of the container. These calculated ignition temperatures are in reasonable agreement with those obtained with our experimental apparatus. The ignition behavior of uranium powder can be adequately described by converting isothermal expressions to a rising temperature basis according to the treatment of Murray, Buddery, and Taylor. (auth)

**4973** MATERIALS FOR THE NUCLEAR INDUSTRY. Nuclear Power, 7: No. 77, 49-59(Sept. 1962).

A survey is presented of innovations in carbon products, cements, ceramics, thermal insulators, lubricants, ferrous and non-ferrous metals, packings and seals, plastics and paints, rubbers, and shielding products for the nuclear industry. (T.F.H.)

**4974** THE NATURE OF FISSION FRAGMENT TRACKS IN URANIUM DIOXIDE. A. D. Whapham and M. J. Makin (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 7: 1441-55(Sept. 1962).

Fission fragment tracks in single-crystal films of uranium dioxide have been observed by diffraction contrast for the first time, and the furrow-type tracks in polycrystalline vacuum-deposited films of uranium dioxide have been studied with the purpose of relating the two types of track. The difference in behavior is explained in terms of exciton, electron, and phonon reflection at the grain boundaries of the vacuum-deposited material. (auth)

**4975** ELECTRON TRANSPORT PROPERTIES IN LIQUID GALLIUM. N. E. Cusack, P. W. Kendall, and A. S. Marwaha (Birkbeck Coll., London). Phil. Mag., (8), 7: 1745-52(Oct. 1962).

Measurements of the Hall coefficient and absolute thermoelectric power of liquid gallium are reported. The former has the 'free-electron' value. All electron transport properties of liquid Ga are collected and discussed in relation to theory. X-ray-diffraction observations are used. (auth)

**4976** THE DYNAMICS OF LIQUID SODIUM BY NEUTRON SCATTERING. S. J. Cocking and K. C. Turberfield (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Phys. Soc. (London), 80: 1201-4(Nov. 1, 1962).

The technique of slow neutron inelastic scattering was used to study liquid sodium at 110°C and to compare the scattering from the liquid with that from the solid at 85°C. (L.T.W.)

**4977** X-RAY DIFFRACTION STUDIES OF THE STRUCTURE OF SOME LIQUID ALLOYS OF INDIUM WITH LEAD AND TIN. A. V. Romanova and A. S. Lashko (Inst. of Physics of Metals, Ukrainian Academy of Sciences). Sb. Nauchn. Rabot Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 15, 87-99(1962). (In Russian)

Three alloys of the In–Pb and two of the In–Sn systems were investigated, in an attempt to clarify the connection between the structure of the solid and liquid alloys and the laws governing changes in the close order as a function of the temperature. The Pb alloys included a Pb-base solid solution with a face-centered cubic structure, containing about 55 at. % In; an In-base solid solution with a face-centered tetragonal lattice containing 87.7 at. % In and having a a/a ratio >1 and a face-centered tetragonal, 77.0 at. % In with a face-centered tetragonal lattice but with a c/a ratio <1. In the In–Sn system alloys with composition of $In_3$–Sn and In–$Sn_4$ were investigated. The first corresponded to a $\beta$ solid solution with a face-centered tetragonal lattice and a c/a ratio <1 while the second has a 2-phase eutectic structure in the temperature range from 60 to 117°C containing a $\beta$ solid solution and a Sn-base solid solution. It was found that melting of the alloys with a closely packed lattice does not result in the degradation of the type of packing. The atoms are statistically distributed in the liquid alloy, with the number of atoms in the first coordination sphere proportional with their concentration. In the In–Pb system an increase by 60 to 70°C above the liquidus temperature tended to transform the close-order structure to a denser, face-centered cubic lattice. No quasieutectic structure appeared in the In–$Sn_4$ system. (TTT)

**4978** PHASE EQUILIBRIUM DIAGRAM OF THE Cr–Ni–$Ni_3Nb$–$NbCr_2$ SYSTEM. V. N. Svechnikov and V. M. Pan (Inst. of Physics of Metals, Ukrainian Academy of Sciences). Sb. Nauchn. Rabot Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 15, 156-63(1962). (In Russian)

The presence of the congruently melting intermetallic compounds $NbCr_2$ and $Ni_3Nb$ in the Cr–Nb and Ni–Nb binary systems makes the existence of quasibinary sections in the Cr–Ni–Nb ternary possible. For the study of this system 180 alloy mixtures were prepared in an arc furnace. The annealed specimens were examined by x-ray diffraction, differential thermal analysis and quenching methods. The isotherms were determined at 50°C intervals. On the basis of the results obtained, the phase equilibrium diagram of the Cr–Ni–$Ni_3Nb$–$NbCr_2$ was constructed. A 4-phase peritectic point was found at 1175 ± 5 and 1160 ± 5°C together with a 4-phase eutectic at 1173 ± 5°C. Addition of Ni resulted in the stabilization of the $\epsilon$-phase (based on the high-temperature modification of $NbCr_2$) in the ternary alloys. At Ni concentrations higher than 5 to 7% the $\beta$-phase (based on the low-temperature modification of $NiCr_2$) could not be observed. All the 4 binaries delimiting the investigated quaternary system were found to possess a eutectic structure. (TTT)

**4979** FORMATION OF THE $\omega$-PHASE IN HAFNIUM-BASE ALLOYS. V. N. Gridnev, V. A. Rafalovskii, and V. I. Trefilov (Inst. of Physics of Metals, Ukrainian Academy of Sciences). Sb. Nauchn. Rabot Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 15, 188-91(1962). (In Russian)

A eutectic phase, similar to the martensite, was previously observed in Ti and Zr alloys; investigation of the possibility of a $\beta \rightarrow \omega$ transformation in Hf-base alloys is of interest because the external electron shells are similar to those of Ti and Zr. In the Hf–Fe system, chosen for the study, an alloy containing 3.5 at. % Fe was more closely examined because its electronic structure corresponds to the previously established critical requirement of $n = 4.14$ electrons/atom. The crystals of the Fe solid solution in

Hf were found to precipitate ($\beta$ phase) together with a eutectic mixture containing the phase and the $Hf_2Fe$ ($\epsilon$-phase). Cooling of the phase results in a eutectoid transformation at 1235°C. Microstructural studies of quenched specimens revealed the presence of the $\beta$-phase and the eutectic mixture, together with the ferromagnetic $\epsilon$ phase $Hf_2Fe$. X-ray diffraction studies indicated the presence of $\beta + \omega$ phase interferences having the following parameters: $a_\omega = 4.55$ Å; $c_\omega = 2.86$ Å. All methods used confirmed the existence of the phase in this system. (TTT)

**4980** ELEVATED TEMPERATURE BEHAVIOR OF A LOW ALLOY AND A STAINLESS STEEL IN HELIUM. Robert G. Shepheard (General Dynamics Corp., Groton, Conn.) and Matthew J. Donachie, Jr. Trans. Am. Soc. Metals, 55: 45-50(1962). (GA-2345)

Studies were made of the rupture behavior of $1\frac{1}{4}$ Cr-$\frac{1}{2}$ Mo steel and 316 stainless steel in air and helium at temperatures of 1000 and 1200°F for the first steel and 1300 and 1500°F for the second to rupture times of about 5000 hr. The plots of log stress vs log rupture life indicated no significant difference in the rupture strength of these steels in air and in high purity helium in the temperature and rupture time interval studied. Variations in fracture behavior were noted and are discussed for both steels. (auth)

**4981** SOME RARE-EARTH ALLOY SYSTEMS. I. La–Gd, La–Y, Gd–Y. F. H. Spedding, R. M. Valletta, and A. H. Daane (Ames Labs., Ames, Iowa). Trans. Am. Soc. Metals, 55: 483-91(Sept. 1962). (IS-414)

The La–Y, La–Gd, and Gd–Y alloy systems were examined by conventional metallurgical research techniques. As would be expected from the similarity of the parent metals, the Gd–Y system exhibits complete solid solubility across the system in both the alpha and beta regions, with nearly perfect behavior indicated by the essentially linear plots of lattice constants and other related data. The La–Y and La–Gd systems show complete solid solubility in the high temperature bcc region, with limited solubility in the room temperature forms. In the central region of these two systems at room temperature, an ordered phase with the samarium structure is observed. Some correlation of structure and lattice constants of this phase with the properties of the related pure metals is observed. (auth)

**4982** DRIFT INSTABILITY OF CARRIERS IN THE SOLID STATE AND THE COHERENT RADIATION OF PHONONS. A. A. Vebenov and E. P. Velikov. Zh. Eksperim. i Teor. Fiz., 43: 1110-12(Sept. 1962). (In Russian)

The dissipation mechanisms that provide the extinction of ultrasound in the solid state and the instability of sufficiently fast drift motions of carriers were examined. Waves were studied that arise in connection with the disturbance of the ionic volume charge in a moving lattice, i.e., sound waves in a charged lattice of a metal or semiconductor. These waves are extinguished by the viscosity of the electron gas. Then waves that do not arise from the ionic volume charge (transverse waves in a dielectric or piezoelectric material) and which are extinguished by the Joule heating of the electrons were studied. It was concluded that the drift motion of carriers is unstable and therefore is suitable for the strengthening of ultrasound. (TTT)

**4983** RESULTS OF MEASUREMENTS OF PHYSICAL PROPERTIES OF PLUTONIUM METAL. Thomas A. Sandenaw (Los Alamos Scientific Lab., N. Mex.). p.152-6 of "The Metal Plutonium." Chicago, University of Chicago, 1961. (LADC-3089)

The electrical resistivity, thermal conductivity, magnetic susceptibility, and heat capacity of Pu were measured at varying temperatures. The electrical resistivity curve shows a maximum at ~100°K, and is relatively constant above room temperature up to the $\alpha \rightarrow \beta$ transition. Very little change in resistivity were noted in the $\beta \rightarrow \gamma$ and $\delta \rightarrow \delta'$ transitions. The magnetic susceptibility changes abruptly at each of the phase transitions and has a positive temperature coefficient only in the $\delta'$ region. The heat capacity measurements below 110°K are not very reproducible. It is suggested that Pu is probably antiferromagnetic. No superconductivity was found. (D.L.C.)

**4984** PLUTONIUM PHASE DIAGRAMS STUDIED AT LOS ALAMOS. F. W. Schonfeld (Los Alamos Scientific Lab., N. Mex.). p.240-54 of "The Metal Plutonium." Chicago, University of Chicago, 1961.

Phase diagrams are presented for the following binary Pu systems: Al, Be, Bi, Ce, Co, H, Fe, Pb, Mg, Mn, Hg, Ni, O, Ru, Th, U, and Zn. Pu was found not to form alloys with Li, Na, K, Ca, Sr, and Ba. Tentative liquidus curves are given, based on the solubilities of W, Ta, Mo, Nb, Cr, and V in liquid Pu. Fragmentary information is also given for 13 other binary Pu systems. The alloying behavior of Pu is reviewed. (D.L.C.)

**4985** RESEARCH IN SPACE MATERIALS. M. A. Steinberg and R. E. Gaumer (Lockheed Missiles and Space Co., [Los Angeles)]. Preprint, IAS Paper No. 62-172. Prepublication Copy. 27p. $1.00.

A review is given on requirements for materials in problem areas, research and development being carried out, and newer concepts in materials applications. Discussion is given on material problems related to atmospheric exit and re-entry, large solid propellant boosters for spacecraft (the motor case problem), and materials for orbital thermal control. (P.C.H.)

**4986** THE DEGASSING BEHAVIOR OF COMMERCIAL GRAPHITES. L. G. Overholser and J. P. Blakeley (Oak Ridge National Lab., Tenn.). p.194-204 of "Proceedings of the Fifth Conference on Conference on Carbon." [New York], Pergamon Press, 1962.

Graphite samples prepared by different commercial graphite producers were degassed in vacuo to a maximum temperature of 1000°C using external radiant heating and to 1800°C by induction heating. Most of the graphites studied were nuclear grade materials prepared from several sources of raw materials and subjected to varying manufacturing procedures. The ash content of the various grades ranged from <20 to ~800 ppm and the calcium content from a few ppm to 340 ppm. The total volume of desorbate varied from ~25 to 50 $cm^3$ STP/100 $cm^3$ of graphite for the high purity graphites to ~100 for the impure grades upon degassing to 1800°C. The composition of the desorbate and the fraction of total evolved to various temperatures also varied widely for the different grades. The volume-time relationship is satisfactorily expressed as $V = A \log t + B$ for many of the graphites at 300, 600, and 1000°C over long time intervals. Cases were found, however, where large changes in the slopes occurred as the degassing progresses. A broad correlation of the degassing behavior with ash content was possible for most of the graphites if the calcium content as well as the total ash content was considered. (auth)

**4987** IMPROVEMENTS IN OR RELATING TO DENSIFICATION AND GRANULATION OF URANIUM DIOXIDE.

Charles Moss (to United Kingdom Atomic Energy Authority). British Patent 910,700. Nov. 14, 1962.

A process is described for the ball milling of uranium dioxide powder compositions to increase the powder density to a top density of at least 3.5 g/cm$^3$. Granules are produced by tumbling of the densified powder. (R.J.S.)

**4988** PROCESS FOR THE PRODUCTION OF BERYLLIUM HAVING INCREASED DUCTILITY AT HIGH TEMPERATURES. Alexander Baillie Brown, Alfred John Martin, and Frederick Morrow (to Babcock and Wilcox Ltd.). U. S. Patent 3,065,117. Nov. 20, 1962.

A process is described for the production of Be having increased ductility between about 300°C and about 700°C. The process involves heating thermally reduced Be, or its equivalent, to above 600°C, holding at a temperature between 600 and 850°C, and then cooling to room temperature. (R.J.S.)

## Radiation Effects

*Refer also to abstracts 5039, 5040, and 5041.*

**4989** (HW-SA-2368) RADIATION EFFECTS IN CARBONS AND GRAPHITES. H. H. Yoshikawa, E. M. Woodruff, J. M. Davidson, J. W. Helm, and R. E. Nightingale (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 19, 1962. Contract AT(45-1)-1350. 20p.

Two simultaneous effects occur during the irradiation of polycrystalline graphite which account for the observed dimensional instability. The first is a disordering of the crystallites which results in an expansion parallel to the c axis and a contraction parallel to the a axis. This process is highly temperature dependent and at room temperature is the principal effect. The second effect is a nonannealable contraction, which acts primarily in the transverse direction in anisotropic nuclear graphite, and seems to occur primarily in the non-graphitic part of the polycrystalline structure. (auth)

**4990** (HW-SA-2814) RADIATION BEHAVIOR OF GRAPHITE MATERIALS. H. H. Yoshikawa (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 25, 1962. Contract AT(45-1)-1350. 10p.

Radiation-induced dimensional changes are emphasized. As a result of reactor radiation at high temperature, conventional graphites contract in both orientations. Pyrolytic carbon contracts in the direction parallel to the planes and expands perpendicular to the planes, while ceramic materials expand. In addition, an oxidation-resistant coating on graphite was shown to be resistant to radiation. (auth)

**4991** IRRADIATION DEVICE ATTACHED TO A REACTOR OF THE INSTITUTE OF NUCLEAR RESEARCH AT THE RUMANIAN ACADEMY OF SCIENCES, BUCHAREST. G. Glanz and I. Olteanu. Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 333-7(1962). (In Rumanian)

A description is given of a device used with a reactor in studying various physical properties of materials irradiated in the reactor. (tr-auth)

**4992** THE EFFECT OF NEUTRON IRRADIATION ON THE STRESS-RUPTURE STRENGTH OF A-286 AND INCONEL X. F. C. Robertshaw and C. G. Collins (General Electric Co., Evendale, Ohio). Am. Soc. Metals, Trans. Quart., 55: 565-79(Sept. 1962).

The effect of neutron irradiation on the post-irradiation stress-rupture properties of A-286 and Inconel X was examined. Substantial reductions in the stress-rupture strength of both alloys at 1200°F and, to a lesser extent, at 1000°F resulted from neutron irradiation at fast neutron dosages of 2.8 × 10$^{18}$ n/cm$^2$ and above. Measurable reductions were observed at a fast neutron dosage of 1.2 × 10$^{18}$ n/cm$^2$. In both alloys, rupture ductility decreased, notch sensitivity increased, and fracture surfaces exhibited the characteristics of brittle materials. Heat treatment following irradiation did not eliminate the effect nor change its magnitude significantly. The specific causes of the effects were not identified; however, it appears that neither transmutations nor atom displacement effects was the principal cause. (auth)

**4993** POST-IRRADIATION EXPERIENCE ON URANIUM IRRADIATED SAMPLES. Catello Cesarano, Ernesto Ghezzi, and Michele Lauro (C.N.E.N., Ispra, Italy). Comit. Nazl. Energia Nucl., Notiziartio, 8: 67-75(Nov. 1962). (In Italian)

A program for the improvement of natural-U fuel elements for gas-cooled reactors is discussed. A 6-in. rig containing 30 U samples was irradiated in the Ispra-1 reactor. All post-irradiation operations are described which were required to dismantle the rig, extract the containers, and remove therefrom the samples to be subjected to metallographic testing. (R.J.S.)

**4994** COMPARISON OF THE EFFECTS PRODUCED BY IRRADIATION WITH NEUTRONS AND WITH $\gamma$ RAYS ON THE EXCITON ABSORPTION SPECTRUM OF CUPRITE. Serge Nikitine, Michel Grosmann, and Jean-Bernard Grun (Faculte des Sciences, Strasbourg). Compt. Rend., 255: 1087-9(Aug. 6, 1962). (In French)

It is shown that the internal electric field created in cuprite by simultaneous irradiation with neutrons and $\gamma$ rays is due to the effect of neutrons. The effect of $\gamma$ rays, on the contrary, permits a decrease of the residual field existing in the crystal. (tr-auth)

**4995** RADIATION-INDUCED CHANGES IN SILICON PHOTOVOLTAIC CELLS. Joseph A. Baicker and Brian W. Faughnan (RCA Labs., Princeton, N. J.). J. Appl. Phys., 33: 3271-80(Nov. 1962).

The effect of both electron and proton irradiation of silicon photovoltaic cells is given in terms of the loss of photovoltaic response and the decrease in the lifetime. Analysis of the spectral response shows that a simple carrier diffusion model provides an adequate description of the behavior of the shallow-diffused junctions that were investigated, and yields values for the minority carrier diffusion length before and after irradiation. Most of the photovoltaic response is shown to occur in the base region of the cells, rather than in the surface layer, and virtually all of the loss of response is caused by defects introduced in the base. The reciprocal of the lifetime is linear with the cumulative irradiation flux, and is consistent with the loss of photovoltaic response. There are significant differences between p on n and n on p cells under electron bombardment; the former damaging roughly 100 times as rapidly as the latter. Under proton bombardment the difference is roughly a factor of three. A comparison of electron, proton, and neutron irradiation suggests that the individual lattice displacements produced in electron irradiation are no more effective in producing recombination than the displacements produced in high concentration in neutron and proton irradiation. (auth)

**4996** DISLOCATION PINNING IN COPPER AT 4.2°K AND IN STAGE I. A. Sosin (Atomics International, Canoga Park, Calif.). J. Appl. Phys., 33: 3373-6(Nov. 1962).

Pure copper samples were electron bombarded at 4.2°K. The elastic modulus was observed to rise in a typically saturating manner during irradiation. Following irradiation, the modulus was observed to increase further in the temperature range from 35 to 50°K. The modulus increase is consistent with the Cottrell-Bilby model of stress-induced diffusion to dislocations. (auth)

**4997** THERMOLUMINESCENCE AND THE INFLUENCE OF $\gamma$-RAY INDUCED DEFECTS IN SINGLE-CRYSTAL $\alpha$-$Al_2O_3$. A. F. Gabrysh, H. Eyring, V. LeFebre, and M. D. Evans (Univ. of Utah, Salt Lake City). J. Appl. Phys., 33: 3389-91(Dec. 1962).

It is shown that light-induced glow curves in $\gamma$-irradiated sapphire have the form of a second-order decay process, namely $I = I_0[b/(b + t)]^m$. Gamma-ray induced thermoluminescence in ruby shows dominant emission bands with maxima at about 150 and 240°K. Light-induced thermoluminescence in $\gamma$-ray-damaged ruby shows an afterglow long after the crystal reaches room temperature. (auth)

**4998** OBSERVATIONS OF CHARGED-PARTICLE TRACKS IN SOLIDS. P. B. Price and R. M. Walker (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 33: 3400-6(Dec. 1962).

The characteristics of tracks produced by fission fragments are studied by transmission electron microscopy in the following layer structure materials: molybdenite ($MoS_2$); talc; clinochlore; jefferisite; and various micas, including biotite, phlogopite, muscovite, and synthetic fluor-phlogropite. The measured track widths show little correlation with the decomposition temperatures and it is concluded that the track formation cannot be described by a simple-thermal-spike model. The absence of any new rings or spots in the electron diffraction pattern of a heavily irradiated sample leads to the conclusion that the tracks themselves consist of a disordered region and not of a definable new crystalline phase. In many of the materials the tracks fade during observation in the beam. Although this fading can be eliminated by using a cold stage, it is not caused simply by the thermal instability of tracks; some materials exhibiting rapid track fading retain tracks to higher temperatures in external annealing experiments than do those in which no fading occurs. Annealing experiments also show that tracks serve to nucleate the high temperature decomposition of natural micas. The results of experiments in which Al absorbers are placed between a fission source and mica samples are interpreted as indicating that only particles with mases $\gtrsim 30$ are capable of forming visible tracks. This conclusion is consistent with the negative results of other irradiations in which mica samples are bombarded with 4-Mev alpha particles, 150-Mev oxygen nuclei, and 3-Bev protons. Experimental observations of the interaction of dislocations with tracks are also presented. (auth)

**4999** CHEMICAL ETCHING OF CHARGED-PARTICLE TRACKS IN SOLIDS. P. B. Price and R. M. Walker (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 33: 3407-12(Dec. 1962).

When a heavy charged particle such as a fission fragment traverses certain materials it leaves a trail of radiation damage, which shows up as a track when a sample is viewed by transmission electron microscopy. If a sample of a silicate mineral containing such tracks is immersed in a suitable reagent, such as hydrofluoric acid, it is found that the tracks are very selectively attacked. Fine hollow channels are formed along the particle paths while the rest of the material is untouched. A study of this effect in various silicate minerals is reported as a function of etching reagent, etching temperature, and etching time. The minimum width of the etched channels is considerably less than the apparent widths of the tracks prior to etching. It is concluded that the track images result in large part from elastic strains surrounding a damaged core. The etching effect also serves to "develop" and "fix" particle tracks, and hence increases the usefulness of silicate minerals as particle detectors. (auth)

**5000** COLOR CENTERS AND THE FLOW STRESS OF LiF SINGLE CRYSTALS. John S. Nadeau (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 33: 3480-6(Dec. 1962).

Lithium fluoride crystals were exposed to cobalt-60 gamma radiation at 300 and 78°K. Changes of the flow stress and of the optical absorption were measured in an effort to relate the hardening to identifiable color centers. In crystals irradiated at 300°K there was found to be a correlation between the flow stress and the concentration of F centers. The magnitude of the hardening, however, suggested that the correlation was caused by interstitial defects. Comparison of the hardening produced by additive coloring with that produced by irradiation indicated that the hardening defects were interstitial fluorines. This direct relation between interstitials and F centers was related to the mechanism for F-center production in the bulk crystal. Some limited experiments with NaCl and KCl showed qualitatively the same behavior. Irradiation of LiF at 78°K produced stable trapped-hole centers, and pulse-annealing experiments showed that the $V_k$ center (self-trapped hole) contributed to the hardness at low temperatures. A sharp decrease of flow stress was observed at about 110°K where paramagnetic resonance experiments and optical measurements indicated disappearance of the $V_k$ center. (auth)

**5001** REACTOR DAMAGE IN PURE METALS. R. R. Coltman, Jr., C. E. Klabunde, D. L. McDonald, and J. K. Redman (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 33: 3509-22(Dec. 1962).

By relocating the fuel in the vicinity of a liquid helium cryostat located in a reactor, it is possible to separate the thermal and fast components of the reactor neutron flux. Studies of the radiation damage effects arising from each type of flux are made. It is found that an appreciable fraction of the reactor damage in several metals arises from thermal neutrons. The effect results from the recoil of an atom from the (n,$\gamma$) reaction at the time of thermal neutron capture. The low-temperature recovery of thermal neutron damage is greater and shows more annealing peak structure than the recovery of fast-neutron damage. Thermal-neutron damage concentration studies are made on cadmium, and pronounced suppression of the annealing is found as the concentration is increased. The mean primary recoil energy from a thermal neutron capture event is calculated for several elements. Values range from about 50 ev for the heavier elements to several hundred ev for the lighter elements. The relative effects of atomic recoils from decay events and decay beta-atom collisions are estimated and found to be small compared to (n,$\gamma$) recoil effects. Damage from fission neutrons is studied in copper, and it is found that the recovery of this damage is suppressed compared to that obtained from reactor fast neutrons. (auth)

**5002** ETCH PIT STUDIES OF DISLOCATIONS IN COPPER CRYSTALS DEFORMED BY BENDING. I. ANNEALED CRYSTALS. II. IRRADIATED CRYSTALS. F. W. Young, Jr. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 33: 3553-64(Dec. 1962).

Annealed and irradiated copper crystals of low initial dislocation density were deformed by bending, and dislocation multiplication and motion were studied using an etch pit technique for observing the dislocations. For the annealed crystals, dislocation motion and multiplication was observed prior to macroscopic yielding, and the percentage of grown-in dislocations moved by the stress increased with the stress. The dislocations were hindered in the motion by subboundaries and by interaction with other dislocations. Relaxation effects were observed and were much greater for stresses less than the yield stress than for higher stresses. For neutron-irradiated crystals there was no motion or multiplication of dislocations prior to yielding. The slip traces were long, with dislocations closely spaced in the trace. Although not conclusive, the evidence was shown to be interpretable in terms of source hardening. A cube-root dependance of the yield stress on neutron dose was observed. No hardening resulted from irradiation with $10^{18}/cm^2$ cobalt $\gamma$ rays. (auth)

**5003** RADIATION DAMAGE AND THE FERROELECTRIC EFFECT IN ROCHELLE SALT. Helmut H. A. Krueger (Clevite Corp., Cleveland), William R. Cook, Jr., C. C. Sartain, and Hubert P. Yockey. J. Appl. Phys., 34: 218-24(Jan. 1963).

Rochelle salt 45° X-cut square plates were exposed to $Co^{60}$ radiation of $8.6 \times 10^3$ to $2.6 \times 10^7$ R and reactor radiation up to $2.4 \times 10^6$ R gamma plus $3.5 \times 10^{15}$ neutrons/$cm^2$. Measurements were made over a temperature range including both Curie points (–30 to +30°C) of dielectric constant and loss, elastic stiffness coefficients $c^E_{44}$ and $c^D_{44}$, and mechanical Q. In addition, double-crystal x-ray rocking curves were made above the upper Curie point to check line broadening. All the data indicate an initial improvement in crystal perfection (Curie points are sharper, linewidths narrower) up to $8.6 \times 10^4$ R, with subsequent degradation (Curie point and linewidth broadening: finally coalescence of Curie points) including elimination of the ferroelectric phase after $2.6 \times 10^6$ R $Co^{60}$ radiation or $2.4 \times 10^6$ R gamma plus $3.5 \times 10^{15}$ neutrons/$cm^2$ reactor radiation. The Q rose with radiation dosage as the ferroelectric phase disappeared, dropping only at the highest dosage. Destruction of the ferroelectric phase by radiation is compared to similar effects due to substitution of $NH_4$ for K in the Rochelle salt lattice. (auth)

**5004** THE IRRADIATION SWELLING OF URANIUM UNDER MECHANICAL RESTRAINT. W. S. Blackburn (C. A. Parsons and Co. Ltd., Newcastle-upon-Tyne, Eng.). J. Nucl. Energy, Pt. A and B, 16: 387-90(Aug. 1962). (In English)

Simultaneous nonlinear differential equations are obtained for the mean strains and stresses in the uranium and in the cladding when a long cylinder of uranium surrounded by a restraining stainless steel cladding is irradiated. The equations are deduced by assuming that swelling of the uranium is due to equally spaced spherical bubbles, that gas atoms obeying the perfect gas law enter the nearest bubble as soon as the gas is produced, and that the presence of the bubbles does not affect the properties of the uranium. The equations are solved for varying thicknesses and strength of cladding both considering and ignoring the creep strength of the material surrounding the bubble. Over the range in the ratio between the thickness and the radius of the cladding considered, the maximum stress in the cladding decreases only slightly with an increase in its thickness. The thicker the cladding the more the swelling is restrained. The cladding is more effective as the bubble spacing increases although the swelling is still greater than that for smaller spacings under an equal restraint. (auth)

**5005** GAMMA-RAY INDUCED CONDUCTIVITY OF CdSe. Hyō Ikawa, On Matumura, and Hiromichi Suzuki (Kyusyu Univ., Fukuoka). Japan. J. Appl. Phys., 1: 236-7(Oct. 1962). (In English)

The variations in electric resistance on single crystals of CdS, CdSe, ZnS, ZnSe, and ZnTe due to gamma irradiation with a $Co^{60}$ source of 3000 c were measured. Samples were prepared by slow cooling from melts of stoichiometric compositions. It was concluded that the excitation takes place uniformly in volume. (W.D.M.)

**5006** CONSTRUCTION OF IRRADIATION CAPSULES FOR GRAPHITE. R. Gain (Institut für Reaktorwerkstoffe der Kernforschungsanlage, Jülich, Ger.). Kerntechnik, 4: 449-52(Oct. 1962). (In German)

Important aspects for the design of non-instrumented capsules for graphite samples, which are to be irradiated close to the temperature of the reactor coolant, are discussed. In the capsules used for this purpose, the temperature distribution is given in dependence on the $\gamma$-heating rate and the dose of fast neutrons. Improvements of the capsule design are suggested. (auth)

**5007** DETECTION LIMITS OF DAMAGES TO FUEL CANS IN WATER-COOLED REACTORS. H. Saeufferer. Kerntechnik, 4: 453-8(Oct. 1962). (In German)

It was established that by any one of the conventional methods of separating fission gases from the coolant, followed by precipitation of their after-products, the detectable rate of damage to the canning material amounts to 1.1 $mm^2$ at a neutron flux of $7 \times 10^{12}$ n/cm/sec. By a novel process it is possible to raise overall efficiency of scrubbing from 11 to 72% and to detect damages to the canning material that are in the region of 0.28 $mm^2$. In addition, it is shown that one minute after the first precipitation, mean activity level of the precipitated fission gas after-products diminishes by about half. (auth)

**5008** DIMENSIONAL CHANGES IN GRAPHITE. W. H. Martin, B. T. Kelly, and P. T. Nettley (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). Nucl. Eng., 7: 484-7(Dec. 1962).

The theory of dimensional changes in polycrystalline graphite is applied to predict the dimensional changes to be expected in Reactor Grade A graphite at different temperatures during the lifetime of the latest British civil stations. The method applied uses data obtained from experiments in the Dido and Pluto materials testing reactors at AERE, Harwell, and assumes a temperature dependence for the dimensional changes of a graphite crystal. (auth)

**5009** A METHOD OF PRODUCING STANDARD RADIOACTIVE SOURCES FOR CALIBRATING DOSIMETERS. Andrzej Kostyrko, Stanisław Pszona, and Krzysztof Zarnowiecki (Inst. of Nuclear Research, Division of Dosimetry, PAN, Warsaw). Nukleonika, 7: 428-9(1962). (In Polish)

A thin source of $Sr^{90}$ + $Y^{90}$ was purchased and measured for uniformity. The nonuniformity was about ±30%. It was then decided to improve the uniformity of such sources. Source thicknesses of 0.2 to 2 mg/$cm^2$ were deposited on a thick plate of plexiglas (methyl methacrylate) by sedimentation. After drying, the plexiglas was exposed to a vapor of chloroform that softened the plexiglas and resulted in a bonding of the radioactive material to the plexiglas. The sources made in this way were $Co^{60}$, $Sr^{90}$ + $Y^{90}$, $Tl^{204}$, and $C^{14}$. Subsequently, sources of $Cs^{137}$, $U^{238}$, and $Pu^{239}$ were also made. The first series was deposited with a uniformity of 3 to 10%, depending on the isotope used. The source dimensions were 100 × 150 mm. (TTT)

**5010** INFRARED ABSORPTION SPECTRUM OF SILICON IRRADIATED BY FAST NEUTRONS. E. N. Lotkova, V. S. Vavilov, and N. N. Sobolev. Opt. Spectry. (USSR) (English Transl.), 13: 118-21(Aug. 1962).

The infrared absorption spectrum of p- and n-type silicon irradiated by neutrons of 1-2 Mev energy was studied in the 1-14 μ region. The investigation was carried out at 290, 78, and 18°K. Bands were observed at 1.8, 3.5, 3.7, and 5.5 μ in n-type silicon and at 1.8, 3.5, 3.7, and 5.9 μ in p-type silicon after irradiation. The appearance of the absorption bands as a result of irradiation is explained by the formation of localized energy levels in the forbidden zone. (auth)

**5011** OBSERVATIONS OF SLIP BANDS IN IRRADIATED PURE IRON. B. L. Eyre (Berkeley Nuclear Labs., Gloucestershire, Eng.). Phil. Mag. (8), 7: 1609-13(Sept. 1962).

Some observations of the effects of neutron irradiation on the appearance of surface slip traces in α-iron are summarized. Tensile specimens of vacuum-melted and strain-annealed iron were electropolished and irradiated to integrated doses (>1 Mev) of $5 \times 10^{17}$, $5 \times 10^{18}$, and $1 \times 10^{19}$ n/cm$^2$. Surface slip traces were studied with the optical microscope. (W.D.M.)

**5012** A STUDY OF STAGE II AND III RECOVERY IN NEUTRON IRRADIATED GOLD AND THE INFLUENCE OF MERCURY IMPURITY ATOMS. D. G. Martin (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag., (8), 7: 1721-9(Oct. 1962). (AERE-R-4073)

Spectroscopically pure gold is neutron-irradiated at −196°C to a dose of $5 \times 10^{17}$ nvt, and the isochronal annealing of the radiation damage up to +100°C is studied from changes in the electrical resistance measured in liquid helium. Three principal annealing peaks at approximately −150, −90, and +20°C, superposed upon a continuous annealing, are observed; the third peak is considerably larger than the other two. An almost identical annealing spectrum is obtained for a 0.25-atomic-per-cent mercury−gold alloy prepared by irradiating gold with thermal neutrons at 80°C, the main difference being that the Hg−Au peaks are slightly smaller. If the alloy is annealed at 345°C for one hour before being irradiated at −196°C the annealing spectrum is even more similar to that observed with pure gold. It is suggested that the first two peaks are caused by the migration of interstitials from impurity traps and the third to the migration of vacancies. It is also suggested that, because of the small effect of the doping, the binding energy between an interstitial and a mercury atom is less than about 0.1 ev. It is inferred that some of the radiation damage introduced during the preparation of the alloys nucleates as small defect clusters around a fraction of the impurity traps. (auth)

**5013** NEUTRON IRRADIATION EFFECTS ON DISLOCATION DAMPING IN COLD-WORKED ALUMINIUM. D. Gelli (Istituto Sperimentale Metalli Leggeri, Novara, Italy) T. Federighi, and F. Pieragostini. Phil. Mag., (8), 7: 1791-4(Oct. 1962).

Fast neutron (>1 Mev) doses of $1.5 \times 10^{14}$ to $1.5 \times 10^{17}$ n/cm$^2$ in Al rods of 99.995% purity at room temperature are studied by measuring the internal friction and dynamic modulus. Pronounced radiation effects are found and ascribed to a dislocation pinning by the point defects introduced by neutron bombardment. Annealing characteristics of irradiated and unirradiated samples are compared. (T.F.H.)

**5014** STORED ENERGY IN THE GRAPHITE OF POWER-PRODUCING REACTORS. J. C. Bell (United Kingdom Atomic Energy Authority, Windscale Works, Sellafield, Cumb., Eng.), H. Bridge, A. H. Cottrell, G. B. Greenough, W. N. Reynolds, and J. H. W. Simmons. Phil. Trans. Roy. Soc. London, Ser. A, 254: 361-95(Feb. 8, 1962).

Experimental and theoretical work on the stored energy associated with atomic displacements produced in graphite by the collisions of fast neutrons, the rate of release of the stored energy as a function of temperature, and the thermal conductivity of graphite, over a range of irradiation and annealing conditions, are described. It is shown how the rate of stored energy release may be estimated for practical values of temperature and irradiation dose. (P.C.H.)

**5015** RADIATION DEFECT INTRODUCTION RATES IN n- AND p-TYPE SILICON IN THE VICINITY OF THE RADIATION DAMAGE THRESHOLD. H. Flicker, J. J. Loferski, and J. Scott-Monck (RCA Labs., Princeton, N. J.). Phys. Rev., 128: 2557-63(Dec. 15, 1962).

Radiation defect introduction rates have been studied in n- and p-type silicon by analyzing the effects of electron irradiation on diffused n on p base and p on n base silicon junctions. The electron energy was varied between 125 and 800 kev; this range included the silicon radiation damage threshold. Plots of the product of the probability of producing a defect and the minority capture cross sections of the defects in the two kinds of junctions exhibited similar dependence on electron energy. However, the magnitudes of these products differed by a factor of about 200 in the two structures, the n on p base junctions exhibiting the slower decay rate. It is shown that although the microscopic nature of the radiation defects may differ in n- and p-type silicon, the rate-determining process is the same in both kinds of material. This process must be the production of vacancy-interstitial pairs as a result of Coulomb scattering by the high-energy electrons. However, the shape of the curve relating the probability of defect introduction to electron energy does not agree with theoretical curves, this in spite of a large increase in reliability of data over previously reported experiments in silicon. (auth)

**5016** RADIATION-INDUCED DILATATIONS IN VITREOUS SILICA. W. Primak and E. Edwards (Argonne National Lab., Ill.). Phys. Rev., 128: 2580-8(Dec. 15, 1962). (TID-15848)

It is shown that when vitreous silica is irradiated in a nuclear reactor, three effects cause dimensional changes: a homogenization effect assigned to fast neutrons (period $\sim 3 \times 10^{20}$ nvt), a compaction (about 3%) assigned mainly to fast neutrons (period $\sim 3 \times 10^{19}$), and a dilatation caused by ionization. The ionization-induced dilatation is negative at the beginning of the irradiation, but becomes positive after a brief irradiation. It probably is responsible for the positive dilatation which occurs after the maximum compaction. Most specimens show internal stresses which give evidence of nonuniform effects. The cause is a radiation gradient due to absorption and/or scattering of the radiation in the specimen. In the period of rapid compaction the strain shows one sign, reaches a maximum, then goes to zero near the maximum in the compaction, and changes sign in the period of expansion. The strain does not seem to saturate when the dilatation saturates. The deformation of the specimens is of the order of magnitude expected from the internal stresses. A thermal effect like a radiation annealing was found in the region between room temperature and 90°C. Results obtained from irradiations by x rays, electrons, as well as by mixed radiation in a nuclear reactor are reported. Because of the concomitant ionization effect it was not found possible to determine the displacement threshold energy by electron bombardment. The ionization effects are taken as evidence of electrostatic effects in the radiation-induced dilatations of silica. However, the electrostatic effects cannot account for all of the volume changes observed in the irradiation of vitreous silica. (auth)

**5017** FISSION-FRAGMENT TRACKS IN METAL AND OXIDE FILMS. K. L. Merkle (Argonne National Lab., Ill.). Phys. Rev. Letters, 9: 150-2(Aug. 15, 1962).

An isolated-particle model is presented to explain track formation in fission-fragment-irradiated thin films. Experimental evidence to support the model is based on observations on Au and Al films. The tracks are explained on the basis that fast-moving fission fragments lose energy mainly by electronic excitations causing localized particle heating and vaporization. Energy transfer processes are discussed for both the metal and metal oxide particle films. (H.D.R.)

**5018** IRRADIATION-INDUCED EXPANSION OF ALKALI HALIDE CRYSTALS AT ROOM TEMPERATURE. D. A. Wiegand (Technische Hochschule, Darmstadt, Ger. and Carnegie Inst. of Tech., Pittsburgh). Phys. Rev. Letters, 9: 201-3(Sept. 1, 1962).

The reflected x-ray intensities in the vicinity of a Bragg maximum are given for irradiated and unirradiated NaCl single crystals and the fractional increase in lattice parameter, ($\Delta d/d$), is calculated from these data. The fractional F-center density and one-third the fractional volume expansion, as determined from photoelastic data, is plotted versus ($\Delta d/d$) for several samples of LiF. The data indicate a substantial increase in the lattice parameter of alkali halide single crystals following x irradiation at room temperature. This suggests that interstitials are generated and/or that there is considerable relaxation in the vicinity of the vacancies. (H.D.R.)

**5019** THE INFLUENCE OF $\gamma$-RADIATION ON CERTAIN PROPERTIES OF CONDUCTING FILMS. O. K. Botvinkin and O. V. Vorob'eva. Steklo i Keram., 19: 4(Jan. 1962).

Glass samples 4 mm thick were covered with $SnO_2$ containing radioactive Sb. The film was applied by spraying an alcoholic solution of $SnCl_4$ at 640°C. The treated film was then irradiated with $\gamma$-rays in dosages of $5.6 \times 10^5$ r. Measurements of the specific conductivity before and after irradiation did not show any noticeable change in the conductivity. (OID)

**5020** THE RESISTANCE OF OXIDE-METALLIC FILMS ON GLASS TO THE ACTION OF IONIZING RADIATION. S. M. Brekhovskikh and I. I. Borisova. Steklo i Keram., 19: 4-6(Jan. 1962).

In a study on the radiation resistance of oxide metallic films on glass, glasses which contained 0.6% $Ce_2O_3$ were used to prevent discoloration up to $10^6$ r. Solutions of $Cd(CH_3COO)_2$, $Co(CH_3 \cdot COO)$, $Ni(CH_3 \cdot COO)$, $Pb(NO_3)_2$, $AgNO_3$, $AlCl_3$, $VCl_3$, $BiCl_3$, $FeCl_3$, $MnCl_2$, $CuCl_2$, $SrCl_2$, $TiCl_2$, $CrCl_3$, $ZnCl_2$, $SnCl_2$, $SbCl_2$, and $B_2O_3$ were sprayed as aerosols on the glass surface near the softening temperature of glass and converted by pyrolysis into metal-oxidic films of 10–100 Å thickness. The films were irradiated with $Co^{60}$ $\gamma$ rays at dosages of $10^3$, $10^5$, and $6.8 \times 10^7$ r. Results showed that the light transmission of AgO and $Al_2O_3$ films changed at $10^3$ r, while all other metal oxide films did not show changes even at $10^5$ r. However, at $6.8 \times 10^7$ r, they all showed changes in light transmission ranging from 18.2% (Sn and Sb) to 47% ($Ni_2O$, CuO). The investigation of electric conductivity of the metal-oxidic films showed that the specific resistance of all coatings did not change under the action of $\gamma$ rays up to $6.8 \times 10^7$ r. (OID)

**5021** THE EFFECTS OF GAMMA RADIATION ON COTTON. PART IV: APPARENT ENERGY OF ACTIVATION OF VISCOUS FLOW FOR DILUTE SOLUTIONS OF IRRADIATED COTTONS. Jett C. Arthur, Jr. and Robert J. Demint (Southern Regional Research Lab., New Orleans). Textile Res. J., 32: 108-11(Feb. 1962).

The interaction of high-energy radiation with cellulose, which leads to the formation of free radicals, excited atoms, or chemical groups, gave decreased intermolecular bonding. The decreased bonding was probably due to the decreased number of interacting anhydroglucose units per molecule. The enthalpy of activation of viscous flow of dilute solutions of purified and irradiated cottons was relatively constant. The entropy of activation of viscous flow was negative and directly related to the molecular weight of the celluloses. Consequently, the free energy of activation of viscous flow for dilute solutions of irradiated cottons was less than for purified cotton. This indicated decreased intermolecular bonding in the irradiated cottons as compared with purified cotton. (auth)

**5022** THE INFLUENCE OF $\gamma$-IRRADIATION ON THE ELECTRIC CONDUCTIVITY OF GLASSES. Toshio Sugiura, Keiichi Murakami, and Hirobumi Tanaka. Yogyo Kyokai Shi, 70: 28-31(Jan. 1962).

The effects of $\gamma$ radiation on the electric conductivity of glasses and the applicability of the irradiated glasses to semiconductive glass or radiation dosimeters are discussed. Ten kinds of glasses were irradiated by a 100-c $Co^{60}$ source up to a max dosage of $10^7$ r. The electric conductivity of each sample was measured by a vacuum tube voltmeter for the range of low resistance values and by a vibration reed electrometer for the high-resistance values. The results showed that no change occurred in the electric conductivity of the glasses subjected to irradiation up to $10^7$ r. Hence, $\gamma$ irradiation is not applicable for making semiconductive glass or glass-dosimeters. (OID)

**5023** PERFORMANCE OF ALUMINUM–URANIUM ALLOY FUEL PLATES UNDER HIGH TEMPERATURE AND HIGH BURNUP CONDITIONS. J. H. Kittel, A. P. Gavin, C. C. Crothers, and R. Carlander (Argonne National Lab., Ill.). Sept. 1962. 20p. ANL-FGF-392. (UAC-6849)

To be published in TID-7642, Proceedings of the Research Reactors Fuel Element Conference held in Gatlinburg, Tenn., Sept. 17-19, 1962.

Irradiation experiments have been made to determine the irradiation temperature and burnup limits for X8001 aluminum alloy-clad Al-17.5 wt % U-2 wt % Ni-0.5 wt % Fe alloy silicon-bonded plates of the type developed for the SL-1 reactor. The irradiations were conducted on prototype SL-1 plates both in MTR capsules and in the ANL-2 High Pressure Water Loop in the MTR. The loop experiments were conducted under local boiling conditions in water at 215°C (420°F) flowing at 12 ft/sec. One of the plates being irradiated in the loop developed a clad defect after a period of operation in high pH water. At the time of clad penetration the plate had achieved a burnup of 58 percent of the uranium (1.3 percent of total fuel alloy atoms). No catastrophic corrosion of the fuel alloy or extensive fission product release occurred when the plate was irradiated with the defect. Because of heavy scale deposition on the loop specimens fuel alloy temperatures were calculated to be as high as 560°C (1040°F). Fuel swelling occurred above temperatures near 450°C (840°F). The silicon bonding technique appeared to be highly effective in maintaining sound metallurgical bonds between fuel and cladding. (auth)

**5024** NEUTRON RADIATION DAMAGE IN COPPER. Irwin Gilbert Greenfield. Thesis, Philadelphia, Univ. of Pennsylvania, 1962. 166p.

Copper single crystals subjected to a neutron dose of $3 \times 10^{17}$ nvt (fast flux) at pile temperatures were examined after deformation by the following experimental techniques: observation of the load-extension relationships; investigation of the slip-line structure with the electron microscope; and diffraction electron microscopy of thinned-down single crystals before and after deformation. The critical resolved shear stress was in the order of 0.16 kg/mm$^2$. In the early stages of deformation, the load-extension curves showed serrations which were as large as 1.0% of the critical resolved shear stress. In the linear portion of the stress-strain curve, the rate of work hardening was less for irradiated single crystals than for the nonirradiated. The stress-strain curves of the irradiated and the nonirradiated specimens were similar in the parabolic region of the curves. The slip-line structure, at low deformations, consisted of fine slip lines that were clustered together; the distances between the slip lines were, on the average, 100 Å and often less; the distances between the clusters were in the order of 4$\mu$. The structure was quite different than the alpha-brass structure, which in the past was considered typical for irradiated copper. Cross slip, which was most abundant in the linear-hardening region of the stress-strain curve, was found to be orientation dependent. The slip-line structures for the irradiated and nonirradiated crystals at high strains were very similar. Prismatic dislocation loops, apparently resulting from the agglomeration of vacancies, were found to be the most frequently produced radiation defect. The interaction between loops and glide dislocations resulted in heavily kinked dislocations which were probably responsible for the observed high yield stress. The glide dislocations were seen to remove the radiation damage. Because of the cleaning out of radiation-produced defects and the ability of the dislocations to multiply from new sources, the prolonged easy-glide range can be explained. Further, the proposed mechanism provided an explanation of the work hardening in the linear and parabolic parts of the stress-strain curve. (Dissertation Abstr., 23: No. 4, 1962)

**5025** FORMATION OF COLOR CENTERS IN POTASSIUM CHLORIDE AS A RESULT OF HIGH ENERGY ELECTRON BOMBARDMENT, AND SUBSEQUENT SELF-BLEACHING. Harvey Schultz. Thesis, Philadelphia, Univ. of Pennsylvania, 1962. 157p.

The effects of electron irradiation on Harshaw KCl are described. Electron pulses of 4.5$\mu$ sec duration, in the energy range of 4.5 to 20 Mev, and with energy deposition rates as high as $10^5$ watts cm$^{-3}$, were used to produce color centers. For F center concentrations less than $6 \times 10^{15}$ cm$^{-3}$, the efficiency F center formation was 1/134 F/ev, independent of electron energy and intensity at 23°C. A large self-bleaching, an annealing out of a large fraction of the F center concentration in the dark at constant ambient temperature, occurred for the first few minutes after irradiation. On further irradiation the efficiency depended strongly on the self-bleaching history and the F center concentration but was independent of intensity. The temperature dependence of the self-bleaching and the F center growth curve was measured at −196°, −78°, 0, 23°, and 90°C. The growth curve for the $V_3$ center was measured at 23°C. The M center, N center, and a center identified as the $AgCl_4^{3-}$ complex, appear in all self-bleached Harshaw crystals for F center concentrations greater than $1.1 \times 10^{17}$ cm$^{-3}$. The efficiency of color center formation in Harshaw KCl and KCl:Ag crystals was compared with "pure" KCl, grown by the same technique as the KCl:Ag but without added AgCl. A model is proposed to explain the measurements of the efficiency of F center formation and of the self-bleaching. The observations indicate that the early rapid growth of coloration was due to vacancies initially trapped at imperfections in the lattice. The self-bleaching resulted from a diffusion mechanism of each vacancy trap after the vacancy was released during irradiation. (auth)

**5026** THE EFFECT OF IONIZING RADIATION ON THE SURFACE PROPERTIES OF SILICA GEL. H. W. Kohn and E. H. Taylor (Oak Ridge National Lab., Tenn.). p.1461-80 of "Actes du Deuxieme Congress International de Catalyse, Paris, 1960." Paris, Editions Technip, 1961. (In English)

The color, adsorptive capacity for $H_2$, and catalytic activity for $H_2-D_2$ exchange of gamma-irradiated silica gel were further investigated. The production of these properties by soft x rays, the destruction of the first two by ultraviolet, and the effect of added impurities indicate that charge carriers trapped at impurity atoms are responsible for the color and the adsorption. The induced catalytic activity appears also to depend upon impurities, and to require only ionization and trapping, not atom displacement, but it is unlikely that the color-adsorption centers are also responsible for the catalysis. Part of the hydrogen adsorbed on radiation-produced sites is held very strongly, but roughly 5% of it will exchange with gaseous $H_2$ or can be removed by evacuation at room temperature. The exchangeable portion is not simply physically adsorbed, because an unirradiated sample shows no adsorption under the conditions of the experiment. (auth)

# PHYSICS

## General and Miscellaneous

*Refer also to abstracts 4444, 4445, 4446, 4447, 4448, and 4771.*

**5027** (AD-273950) FERRO- AND ANTIFERROMAGNETISM IN A CUBIC CLUSTER OF SPINS. Technical Report No. 254. C. F. Dresselhaus (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). Jan. 11, 1962. Contract AF19(604)-7400. 22p. (AFESD-TDR-62-71)

The Heisenberg exchange Hamiltonian was solved exactly for a cubic array of eight spins (each with spin $\frac{1}{2}$). Both energy eigenvalues and thermodynamic functions were calculated. A Curie and a Neel temperature can be defined and their values determined as a function of the strength of first, second, and third neighbor interactions. For some values of the exchange constants, spiral antiferromagnetic states exist. (auth)

**5028** (AFCRL-62-423) THE INTERPLANETARY MAGNETIC FIELD AND THE AURORAL ZONES. Scientific Report No. 157. J. W. Dungey (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Mar. 15, 1962. Contract AF19(604)-4563. 33p. (AD-274336)

It was found that a model with a southward interplanetary magnetic field leads to a natural explanation of the SD flow currents. Speculative aspects of the problem as they appear at this time are discussed. (auth)

**5029** (AFCRL-62-623) A THEORETICAL DISCUSSION OF DIFFUSION AND DRIFT IN THE F2 REGION. Final Technical Report. V. C. A. Ferraro (London. Univ. Queen Mary Coll.). Nov. 30, 1961. Contract AF61(052)-299. 127p. (AD-276931)

The equation governing diffusion and drift in an isothermal plane stratified F2 region is developed, and an analytical solution is derived in terms of the Green's function. The solution is used to study the response of the region to a distribution of ionization produced by a pulse of solar radiation, to simulate the diurnal change in electron density occurring in middle latitudes, to construct world curves of maximum electron density, and to study the behavior of the F2 region during solar eclipse. (auth)

**5030** (AFOSR-2114) PARAMAGNETIC RESONANCE OF RARE EARTH IONS WITH A $\Gamma_8$ GROUND STATE. Technical Note No. 17. W. Low and G. Vincow (Hebrew Univ., Jerusalem). Contract AF61(052)-59. 18p. (AD-273497)

In rare earth ions it is often found that the ground state consists of a degenerate quartet. Cases when this may occur are discussed. The spin Hamiltonian is solved for the particular case of f3 and the angular variation as well as the transition probabilities are computed. The theoretical calculations are compared with the experimental data obtained for $Nd^{3+}$ and $U^{3+}$ in cubic sites of $CaF_2$. A short description on the thermal treatment is given. (auth)

**5031** (AFOSR-2535) HYPERFINE INTERACTIONS IN THE 2+ ROTATIONAL STATE OF $Dy^{160}$ IN DYSPROSIUM IRON GARNET. Technical Note No. 6. R. Bauminger, S. G. Cohen, I. Nowik, and S. Ofer (Hebrew Univ., Jerusalem). Feb. 1962. 31p. (AD-274553)

The hyperfine interactions of the 2+ rotational level of $Dy^{160}$ at 87 kev in dysprosium–iron garnet were measured at 94°K using the technique of Mössbauer absorption. A comparison with previous similar measurements in $Dy^{161}$ together with the knowledge of the g factor of the $Dy^{161}$ ground state from spin resonance experiments gave a value of 0.48 ± 0.07 for the g factor of the 2+ rotational level of $Dy^{160}$. The sign of the spectroscopic quadrupole moment of this state was negative. The ratio of quadrupole moments Q sub 160 (2+)/Q sub 161 (ground state) was −0.77 ± 0.25. Comparing a model dependent estimate of Q sub 160(2+) with a value of Q obtained from the experimental results, a value of about 0.2 is obtained for the Sternheimer shielding factor. (auth)

**5032** (BLG-123) SOME REMARKS ON SMAKULA'S FORMULA FOR F-CENTER CONCENTRATIONS. R. Strumane (Brussels. Centre d'Étude de l'Énergie Nucléaire). June 1962. 3p.

Smakula's formula for F-center concentration has given rise to much confusion in the literature. An attempt is made to clarify the situation. The formula was calculated by two different approaches, and the correct versions are given. (auth)

**5033** (HW-70230) PROPOSED BAND STRUCTURE OF $CaF_2$: Mn. D. E. Hegberg and H. A. Treibs (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 25, 1961. Contract [AT(45-1)-1350]. 8p.

A method which was used to obtain high-resolution transmission absorption spectra from polycrystalline $CaF_2$: Mn is described. An analysis of the spectra in terms of band structure as generally applied to ionic crystals is included. It is noted that in dealing with band structure, it is unwise to insist on precise agreement between theoretical formulas and experiment; however, fairly good agreement between the proposed band structure of $CaF_2$: Mn and theory was obtained. (J.R.D.)

**5034** (ORNL-3354) STUDIES OF THE SCINTILLATION PROCESS IN CsI(Tl). R. Gwin and R. B. Murray (Oak Ridge National Lab., Tenn.). Nov. 30, 1962. Contract W-7405-eng-26. 134p.

The scintillation response of CsI(Tl) crystals, having various thallium contents, was measured for excitation of the crystals by monoenergetic gamma rays, protons, and alpha particles. The investigation was made to provide a test of some of the features of a theoretical model of the scintillation process in thallium-activated alkali iodides proposed by Murray and Meyer. In order to insure that the results obtained in this program would provide a critical test of the scintillation model, special attention was paid to technical effects which could influence the interpretation of the experimental data. For example, the effect of the pulse-analysis time on the relative scintillation response of CsI(Tl) to various charged particles was investigated. In addition, the emission spectra of the CsI(Tl) crystals were measured for excitation by x rays, protons, and alpha particles. The results of the investigation showed that the scintillation efficiency of CsI(Tl) is a continuous function of dE/dx, as assumed in the scintillation model, within the accuracy of the experiments when the effect of delta rays are considered. This led to the conclusion that the light output of CsI(Tl) crystals is, in general, a nonlinear function of the energy of the particle. The shape of the dL/dE versus dE/dx curve for CsI(Tl) crystals is shown to be nearly independent of the thallium content of the crystal. This is in distinct contrast to the predictions of the scintillation model. An examination of the emission spectra of CsI(Tl) crystals showed that light is emitted in a band, centered at about 3300A, which is characteristic of the emission of the pure crystal, as well as the characteristic thallium luminescence. The relative intensity of this luminescence with respect to the thallium-activator luminescence increases as the ionization density in the crystal increases and increases as the thallium content decreases. It is suggested that the emission band characteristic of pure CsI crystals is associated with the decay of an iodine molecule ion of the type $I_2^-$ which has trapped an electron. On this basis it is suggested that thallium-activator luminescence results from the successive capture of an electron and a hole at a thallium center. The 3300A emission band of CsI overlaps the optical-excitation spectrum of CsI(Tl) for thallium-activator luminescence. Some thallium centers in CsI(Tl) are therefore excited by optical emission in the 3300A band. (auth)

**5035** (ORNL-3364) SOLID STATE DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING AUGUST 31, 1962. (Oak Ridge National Lab., Tenn.). Nov. 26, 1962. Contract W-7405-eng-26. 230p.

Research progress is reported on solid-state theory, crystal physics, metals, nonmetals, radiation metallurgy, and reactor materials. Separate abstracts were prepared for each topic. (M.C.G.)

**5036** (ORNL-3364(p.1-26)) PART I. THEORY. D. K. Holmes (Oak Ridge National Lab., Tenn.).

By use of the hard-sphere approximation formalism of Holmes and Leibfried, ranges of energetic atoms in solids were calculated with a hard-sphere radius defined so that the hard-sphere stopping power matches the "Bohr" stopping power at every energy. These calculated ranges were found to be in much better agreement with the Monte Carlo results than those found by using a hard-sphere radius equal to the distance of closest approach in head-on collision. Ranges of energetic atoms in solids were studied theoretically by means of a mathematical model which incorporates the full lattice symmetry, as contrasted with earlier work in which the lattice was randomized to facilitate computation. The most striking effect noted is the possibility that an atom may become "channeled" along certain directions in the lattice (such as the ⟨110⟩ in an fcc lattice) and move past many hundreds or thousands of lattice atoms with only slight energy loss. The relationship between the impact parameter and the energy transferred was studied in the hard-sphere approximation for two different choices of the hard-sphere radius and was compared with exact results. Experimental studies of the sputtering of copper monocrystals by rare-gas ions in the kev range demonstrated the dramatic dependence of the sputtering yield (the number of target atoms ejected per incident ion) on the orientation of the ion beam with respect to the crystallographic axes of the target crystal. Similar experiments on germanium with 1- to 5-kev $Ar^+$ ions reveal only a small dependence on orientation. Some success was attained in understanding the copper data on the basis of a simple, essentially geometrical, model, and studies are in progress, both to improve the calculations and to extend them to targets of other symmetries. A procedure is given to calculate the energy dependence of sputtering yields of single crystals for any surface orientation. Explicit calculations were made for $Cu^+$ bombardment of copper under normal incidence for a (100), a (110), and a (111) surface. When a flux of charged particles impinges on a charged capturing center, the capture probability is modified by Coulomb attraction or repulsion. A function which relates the experimentally observed capture probability to an atomic capture probability is defined and tabulated. At certain points, lines, and (internal) planes in the reduced Brillouin zone, here called critical 0-, 1-, and 2-simplices, the energy as a function of propagation vector has an algebraic form more complicated than that of Wigner and von Neumann. The first few 0-simplices are given for the case of a square lattice of points. An experiment is proposed whereby the Mössbauer effect might be observable following thermal-neutron capture in certain materials. It is pointed out that the atom emitting the Mössbauer (recoilless) radiation may very well be in an interstitial position. In case it is so located, ways are discussed in which the interstitial position may affect the spectra of the Mössbauer radiation. An IBM 7090 computer program was written for calculating the number of primary displaced atoms produced by energetic electrons. The program evaluates numerically the Mott series and is good, therefore, for elements of arbitrary Z. It is being extended to include the cascade of displacements produced by the primary knock-on. (auth)

**5037** (ORNL-3364(p.27-56)) PART II. CRYSTAL PHYSICS. M. K. Wilkinson (Oak Ridge National Lab., Tenn.).

A Lang camera utilizing a conventional x-ray source together with a portable crystal rocker is described. Thermal measurements indicated that significant amounts of graphite-stored energy exist in the unannealed corner regions of the ORNL Graphite Reactor moderator stack. The large central region of the moderator core contains no spontaneously releasable stored energy. Preliminary observations on irradiated $UO_2$ single crystals have indicated that fission-fragment tracks are confined to surface regions of the material. Reaction between the $UO_2$ and the organic material occurred during irradiation in polyethylene vials. This reaction led to extensive microcracking and indicated sensitivity of $UO_2$ to the environment during irradiation. The a-c conductivity of an irradiated lead silicate glass was observed to increase monotonically with decreasing frequency, and the d-c conductivity of the glass could be expressed as a sum of four time-dependent exponential functions plus a constant. These polarization processes were characteristic of the bulk material. A possible mechanism for storage of charge and energy which can result in the discharge effect may be found in such bulk polarization of certain glasses. The dependence on magnetic field and orientation of the superconducting critical current of several Nb-Zr alloys was studied in the ORNL 100-kilogauss magnet. Data on cold-worked and heat-treated materials are reported. The tensile properties of commercially available Nb–25% Zr wire were determined at 300, 77, and 4.2°K. The effect of neutron irradiation at 3.5°K on the superconducting transition of tin was investigated. (auth)

**5038** (ORNL-3364(p.57-84)) PART III. METALS. F. W. Young, Jr. (Oak Ridge National Lab., Tenn.).

Effects of surface orientation and defect structure on the anodic dissolution of copper are discussed. The role of current density, solution composition, and orientation of the electrode surface in the development and growth of etch pits at dislocations was examined. The rate of growth of pits at dislocations and other changes in surface topography were measured. The results are explained on a kinetic and geometric basis. A method for producing copper crystals of low dislocation density by annealing crystals grown by a modified Bridgman technique is described. Thermal- and fast-neutron damage effects were studied separately in high-purity metals irradiated near 4°K. Unmoderated fission neutron damage was studied in copper. By use of the effect of the suppression of isochronal recovery due to thermal-neutron dose in cadmium, an estimate is made of the defect concentration within a damaged region resulting from a fast-neutron hit. Preliminary flux measurements of a high-purity thermal-flux facility and the construction progress of an associated 4°K irradiation facility are reported. Measurements of the internal friction and Young's modulus of a copper single crystal were performed in which it was apparent that the number of dislocation pinning points introduced by neutron bombardment at 100°C is not a constant when measured as a function of temperature subsequent to bombardment. Analysis of the pinning-point behavior was made in terms of the Granato-Lücke theory of internal friction. It was found that after light bombardments the pinning-point behavior can be described by second-order equilibrium with a binding energy of about 0.3 ev. After larger doses the results are more complex. It is thought that the general results may be due to vacancy clustering in dislocations. Analysis of a previous experiment on the internal function in copper at megacycle frequencies was redone, taking into account a more accurate theory of oscillatory dislocation motion and correcting for the distortion of time scale caused by delay in migration of radiation-defect pinning points from their places of creation to the dislocations. The frequency dependence now indicates that probably only one dislocation component was important. It appears that an increasing fraction of pinning points is lost as irradiation proceeds. Determinations were made of the argon retained in copper after bombarding polycrystalline copper with 4-kev argon ions. Atom ejection patterns were obtained for the three major planes of aluminum and the (0001) plane of zinc, and the sputtering yield is reported for the (111) plane of aluminum. (auth)

**5039** (ORNL-3364(p.85-124)) PART IV. NON-METALS. J. H. Crawford, Jr. (Oak Ridge National Lab., Tenn.).

The annealing properties of irradiation-induced carrier change in antimony-doped germanium were studied by using both isochronal and isothermal annealing. The irradiations were conducted at liquid-nitrogen temperature by using $Co^{60}$ gamma irradiation. A model which explains the observed annealing behavior is proposed. Direct-current photoconductivity measurements are being used in conjunction with transient measurements to determine the properties of traps previously observed in arsenic-doped germanium. Although 40% of the carriers were removed from a 2-ohm-cm n-type germanium sample by $Co^{60}$ photon irradiation, the Seebeck coefficient remained relatively unchanged. A definitive experiment, using 0.2-ohm-cm n-type germanium, is in progress which will establish the validity of the premise that the Seebeck coefficient is less sensitive in antimony-doped germanium to $Co^{60}$ photons than the theory predicts. Preliminary optical studies of $Co^{60}$ gamma-ray and reactor-neutron-irradiated single crystals of zinc sulfide indicated no observable change in the absorption spectrum. Measurements of electronic properties are expected to be a more sensitive indicator of radiation damage than are optical absorption data. Therefore, work is in progress to prepare suitable specimens for electrical measurements. Small single crystals of cinnabar were grown by utilizing the temperature dependence of the reaction $HgS + I_2 \rightleftharpoons HgI_2 + \frac{1}{2}S_2$. Attempts are being made to grow crystals large enough for electrical measurements. There is considerable evidence to indicate that the effects of $Co^{60}$ gamma-radiation damage upon the electrical properties of $Bi_2Te_3$ vary in a consistent manner with the atomic percent of tellurium in the specimen. A possible interpretation is that gamma radiation creates Frenkel pairs consisting of substitutional bismuth and tellurium atoms in p-type and n-type $Bi_2Te_3$ respectively. A variation in the anisotropy of scattering upon extended irradiation appears to be responsible for certain of the observed effects. It is believed that further analysis of the gamma-radiation damage of the material will lead to a more quantitative understanding of the doping mechanism and band structure in $Bi_2Te_3$. A number of preliminary experiments were considered or conducted in relation to their potential application toward ascertaining the experimental threshold energy required for the production of defect clusters (disordered regions) in materials. The apparent p-type carrier concentration and acceptor level position of $Co^{60}$ photon-irradiated germanium are shown to be dependent on the initial dislocation content of the material. Ceric sulfate reduction and ferrous sulfate oxidation techniques were used to confirm the predicted flux of capture gamma rays inside a thermal-neutron shield. Investigations of radiation coloring with special emphasis on the relation between F- and M-centers in heavily colored KCl showed that the M-center concentration is proportional to the square of the F-center concentration, with the constant of proportionality depending upon the purity of the KCl samples, and the intensity of ionization. The proportionality constant is not changed by plastic deformation of the sample, nor is it dependent upon the energy or type (electrons or gamma rays) of irradiation. After heavy coloring the ratio of F- to M-centers can be changed by a short re-irradiation at a different ionization intensity. This process is reversible, indicating that F- and M-centers are in equilibrium during irradiation at room temperature. The effect of gamma irradiation on KCl samples doped with Ca, Sr, Cd, and Mg was studied. The data apparently indicate that crystals containing Mg and Cd have relatively fewer free positive-ion vacancies than those doped with Ca or Sr. Luminescent spectra of several alkali halides were taken during and immediately following gamma irradiation at $5 \times 10^6$ r/hr. Several broad maxima were observed in some spectra, and one spectrum showed an intense impurity band in the ultraviolet region. An extensive program is being conducted to develop the techniques to produce high-purity research specimens of immediate and long-range interest. A procedure was developed to obtain parallel polished faces on single-crystal specimens of $Cu_2O$. Preliminary results were obtained between 25,000 and 6000 A for the optical absorption at room temperature, at 80°K, and as affected by $Co^{60}$ photon irradiation. A pulling furnace for KCl was built. Crystals ranging to 3 × 3 × 10 cm were grown. The purpose and operation of the Solid State Division's Research Materials Information Center, which will provide information on the methods of production, availability, need for, and characterization of high-purity solid-state research materials to both producers and users, are described. Details of system automation and analysis for coding are not included. Some degree of purification of $Bi_2Se_3$ can be realized by control of the partial pressure of selenium over the crystal. The purification is controlled by self-diffusion of bismuth within the lattice, a process which has an activation energy of approximately $3 \times 10^4$ cal/mole. It appears that purification of $Bi_2Se_3$ can be considerably enhanced by regulation of the constituent-element vapor pressure over the growing crystal. A modified Teal-Little crystal-growing furnace was constructed for this purpose. (auth)

**5040** (ORNL-3364(p.125-50)) PART V. RADIATION METALLURGY. M. S. Wechsler (Oak Ridge National Lab., Tenn.).

A discussion is given of the time dependence of the interstitial and vacancy concentration during irradiation when these defects anneal by the combined processes of diffusion to fixed sinks and interstitial-vacancy recombination. The dependence of the radiation-enhanced diffusion on the displacement production rate and the irradiation temperature is summarized for this annealing process and for the two simple constituent annealing processes considered separately. An experimental investigation of the flux dependence (dependence on the displacement production rate) of radiation-enhanced ordering in Cu–15 at. % Al was conducted by measuring electrical resistivity during ordering at 100°C at various locations in the reactor. The neutron flux is determined by using a number of thermal, epithermal, and threshold detectors. The results indicate that the rate of reaction at a given temperature varies as the square root of the flux. Apparatus is being developed for the measurement of stress relaxation and low-frequency internal friction of iron alloys containing carbon and/or nitrogen during irradiation. A discussion is given of the application of these techniques to the study of the effect of radiation on the precipitation of carbides and nitrides in $\alpha$-iron. In-pile tube-burst experiments on various engineering alloys (Inconel, 304 stainless steel, Zircaloy-2, and Nb–1% Zr) are described. The chief effects of the irradiation are to shorten the rupture life at a given stress and to decrease the deformation at fracture, although in certain cases no change in property was detected. The results of impact tests on pressure-vessel steel surveillance samples taken from the SM-1 reactor after 16.4 and 20.8 Mwyr of operation are reported. The increases in brittle-ductile transition temperature are somewhat in excess of those predicted by accelerated-irradiation tests. Several reasons for this observation are discussed. (auth)

**5041** (ORNL-3364(p.151-200)) PART VI. REACTOR MATERIALS. O. Sisman (Oak Ridge National Lab., Tenn.).

Postirradiation evaluations were performed on dispersions of coated and uncoated $UC_2$ in graphite. The fission product gradient was measured across a graphite can containing the fuel specimens. Pyrolytic-carbon-coated $UC_2$ particles were examined after irradiation at elevated temperatures. Both columnar and laminar coatings were also tested for fission-gas retention during irradiation. Pellets of $UO_2$ clad in stainless steel were examined after irradiation. These EGCR-prototype fuel capsules were irradiated in the ORR and the ETR. Beryllium-canned $UO_2$ and fueled BeO were also included in the evaluations. Thin-plate specimens of fused-crystal and single-crystal $UO_2$ were irradiated in a reducing atmosphere. The releases of xenon, krypton, and iodine were compared as a function of temperature, specimen structure, stoichiometry, and neutron flux. Electrical resistivity measurements of the three types of $UO_2$ were obtained during irradiation. Comparisons were made of the in-pile performance of Pt vs Pt–10% Rh thermocouples with W–5% Re vs W–26% Re in a reducing atmosphere. Maritime reactor prototype fuel elements were examined after irradiation. Cold-swaged and vibratory-compacted $UO_2$ were used in the tests to determine fuel-rod stability as well as fission-gas release. Postirradiation evaluations continued on sintered and powdered $UO_2$-$ThO_2$. The investigation of differences in the effects on polystyrene of gamma radiation and mixed reactor radiation was extended to infrared and gas chromatographic analysis. Infrared spectrum measurements showed more rapid growth of certain bands in reactor-irradiated specimens than in specimens exposed to gamma radiation alone. The volatile products of gamma irradiation of polystyrene indicated by gas chromatography were hydrogen, $G(H_2) \sim 1.5 \times 10^{-2}$ molecule per 100 ev, and benzene, $G(C_6H_6) \sim 5 \times 10^{-4}$ molecule per 100 ev. A versatile gamma source comprising a $Co^{60}$ assembly in a 7 × 10 ft shielded compartment was designed for the irradiation of plastics and rubbers during mechanical testing. Equipment is described which is suitable for thermal analysis of small samples of nonmetallic materials. Calibration by means of Peltier power makes the method quantitative below about 900°C. Irradiation in a reactor causes zircon ceramic to resemble metamict zircon in the changes undergone on heating. Heating produces partial annealing at relatively low temperature, decomposition at higher temperature, and re-formation of zircon at still higher temperature. Not all of these processes may occur, depending on the irradiation dose. The acid concentration produced by irradiation of solutions of $C_2H_2Cl_4$ in $C_8F_{16}$ and in $C_{10}H_{22}$ was measured to determine the suitability of these systems as dosimeters. The $C_8F_{16}$ solutions, to which 0.3 wt % $C_{10}H_{22}$ was added to provide an adequate source of hydrogen, showed inconsistent acid yields unless water in excess of saturation (0.2 wt %) was present. The $C_{10}H_{22}$ solution showed a dependence on both the temperature and dose rate during irradiation. (auth)

**5042** (RADC-TDR-62-67) ELECTRON DIFFUSION IN A MULTIMODE CAVITY. Technical Note No. 1. A. D. MacDonald (General Telephone and Electronics Labs. Inc., Palo Alto, Calif.). Jan. 15, 1962. Contract AF30(602)-2501. 15p. (AD-274214)

An approximate solution of the diffusion equation describing electron diffusion in a multimode rectangular cavity is described. The results indicate that the electron concentration builds up in the spaces between the maxima of ionization. This means that the breakdown electric field is characteristic of a diffusion length approximating that of the lowest diffusion mode. (auth)

**5043** (RM-3058-NASA) A CHARGE-SEPARATION MECHANISM FOR THE PRODUCTION OF POLAR AURORAS AND ELECTROJETS. J. W. Kern (RAND Corp., Santa Monica, Calif.). Mar. 1962. Contract NASr-21(05). 49p. (AD-274182)

A mechanism for charge separation in geomagnetically trapped radiation is described which may account for some observed phenomena associated with the polar aurora and the electrojet current systems. Surfaces of constant number density may be separated from surfaces of constant integral invariant within the trapped radiation as a result of distortion of the geomagnetic field by solar streams. Drift separation of protons and electrons follows, and for irregular distributions of plasma number density, electric fields arise. A direct consequence of such polarization of the geomagnetically trapped radiation is the polar-electrojet current systems. The polar aurora arises where energetic particles are discharged from regions of excess charge within the geomagnetically trapped radiation. A model for the discharge of such auroral particles is discussed. A feature of the proposed mechanism is that the extreme thinness of auroral sheets appears to follow as a natural consequence of charge separation. This is shown analytically for a simple two-dimensional model of a trapped plasma. (auth)

**5044** (RM-3391-PR) RADIO WAVE ABSORPTION DUE TO ELECTRON-ION COLLISIONS IN THE EARTH'S ATMOSPHERE ABOVE 100 km. C. M. Crain (RAND Corp., Santa Monica, Calif.). Nov. 1962. Contract AF49(638)-700. 23p.

Calculations and graphs are presented showing the attenuation of radio waves in low-density ionized gases, in which the principal contribution to attenuation is due to electron-ion collisions. Numerical results are presented for electron temperatures in the range of 1000 to 40,000°K, for plasma frequencies in the range of 10 to 10,000 Mc, and for transmission frequencies in the range of 1 to 10 times the plasma frequency. The results are particularly applicable to the earth's atmosphere above about 100 km under conditions of abnormally high ionization, such as may result from a high-altitude nuclear detonation. (auth)

**5045** (TID-14794) AN EMPIRICAL APPROACH TO THE PROBLEM OF ANOMALOUS DISPERSION. R. B. Roof, Jr. (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract [W-7405-eng-36]. 35p. (LADC-5232)

One hundred and sixty-five experimental or empirical atomic scattering curves were compared with the theoretical curves through the use of a three-parameter equation that allows the empirical values of the anomalous dispersion corrections, $\Delta f'$ and $\Delta f''$, to be determined. A significant difference between theory and experiment was found only for $\Delta f'$ in the region of the $L_{III}$ absorption edge, where the empirical correction is approximately twice that theoretically calculated. (auth)

**5046** (UCRL-10477) ON THE MEASUREMENTS OF LIFETIMES, EXCITATION FUNCTIONS, DENSITIES, TOTAL CROSS SECTIONS, AND POLARIZATION RATIOS OF THE METASTABLE STATE OF THE NEON ATOM UNDER ELECTRONIC IMPACT (thesis). Tetsuo Hadeishi (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 25, 1962. Contract W-7405-eng-48. 101p.

The values of lifetimes, excitation functions, densities, total cross sections, and polarization ratios of the metastable state $(2\,{}^2P_{3/2}\ \ 3\,{}^2S_{1/2})_2$ of Ne at various pressures under electronic impact were measured by use of an electron gun. A method of obtaining the total cross section from the measurement of lifetime, electron flux, excitation function, and width of the resonance line is derived and discussed. Two apparent lifetimes of the metastable state were found, one of which is much shorter than the other at the same potential. The longer one is in agreement with previously published results; however, the shorter one is not. The longer lifetime was thought to be caused by high lying metastable states feeding into the lower metastable state. The shorter lifetime is less sensitive to the variation of pressure. The observed half-lives are 0.428(17), 0.452(33), 0.497(16), and 0.451(36) msec at the pressure settings of 0.41, 0.69, 1.03, and 1.68-mm Hg, respectively, at 300°K (the numbers in parentheses indicate a plus or minus error in the last two digits). The measured values of the half-lives corresponding to the longer lifetime are 2.5(1.8), 4.8(4.0), 8.3(7.5) msec for the pressure settings of 1.68, 1.03, and 0.69-mm Hg at 300°K. The measured average value of the density of the metastable-state atoms is $5.3(1.5) \times 10^9/\text{cm}^3$. The measured average total cross section is $1.2(0.6) \times 10^{-19}\ \text{cm}^2$. The polarization ratio—defined by $(\Delta I_\perp - \Delta I_{||})/(\Delta I_\perp + \Delta I_{||})$, where $\Delta I_{||}$ and $\Delta I_\perp$ are the intensities of the absorbed light when the electric vector is parallel to and perpendicular to the direction of the electron beam—showed a positive value only at the excitation potential very close to the threshold of excitation. The polarization ratios measured were negative for excitation potentials higher than 2V above the threshold of excitation. Even though a negative polarization ratio was obtained for electron energies greater than 19V, it is believed that this cannot be used for r-f resonance. Details of the apparatus used to measure these quantities associated with the metastable state of the neon atom are given, and results are discussed. (auth)

**5047** (AD-275256) GEOMAGNETIC, AURORAL, IONOSPHERIC AND COSMIC RAY DISTURBANCE: THEIR INTERDEPENDENCE AND RELATIONSHIP WITH SOLAR ACTIVITY. F. Mariana and F. Molina. Translated from Ann. Geofis. (Rome), 13: 85-128; 297-368; 389-437(1960). 213p.

A discussion is presented concerning auroras, geomagnetic storms, ionospheric storms, and cosmic-ray storms which may be affected by solar events. Included are sections containing observational data and information on auroras and the various types of storms and their correlation with solar activity. Theories and hypotheses associated with these phenomena are also discussed. (J.R.D.)

**5048** (UCRL-Trans-852(L)) ON RECOMBINATION OF PHOSPHORESCENCE. V. V. Antonov-Romanovskii. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Berkeley) from Izv. Akad. Nauk SSSR, Ser. Fiz., 10: 477-87(1946). 17p.

A review of opinion concerning the mechanism involved in illumination of phosphors by recombination of electrons is presented. The emphasis of the discussion is centered around the work of Randall, Welkins, and Garlick (Proc. Roy. Soc., 184: 366-390, and 408). (J.R.D.)

**5049** (UCRL-Trans-853(L)) ON THE FLASH MECHANISM OF SrS-PHOSPHORS, ACTIVATED BY RARE-EARTH ACTIVATORS, AND THE INTERACTION OF THE ACTIVATORS. V. V. Antonov-Romanovskii, V. L. Levshin, Z. L. Morgenshtern, and Z. A. Trapeznikova. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Berkeley) from Izv. Akad. Nauk SSSR, Ser. Fiz., 13: 75-90(1949). 26p.

Studies were made of the flash mechanism and "lighting out" of phosphors. A comparison was made of the properties of double-activator and single-activator phosphors. The nature of the levels of localization, the light spectra, effects of Ce and Eu on light spectra in phosphors, the spectrosensitivity of the flash phosphor with different activators, and storage of the light sum and the flash at different temperatures were studied. It was found that in phosphors with two rare-earth activators these activators become located together, thus forming a complex center of lumination. The centers of lumination also appeared as centers of localization of the electrons and as absorption centers of the "lighting out" light. The light sum storage at deep local levels was found to depend on the temperature at which excitation takes place. (M.C.G.)

**5050** RELATIVISTIC EQUATION FOR HYPERFINE STRUCTURE. N. J. Ionescu-Pallas (Inst. of Nuclear Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 101-4(1962). (In Rumanian)

A precise formula was derived for the relativistic correction of the interval factor of $S_{1/2}$ electrons. The formula holds for a state with finite main quantum numbers. The Racah correction factor results as a limiting case. (auth)

**5051** DENSITY MATRIX REPRESENTATIONS. J. D. Patterson (Idaho State Coll., Pocatello). Am. J. Phys., 30: 894-7(Dec. 1962).

The relations between the ordinary density matrix, the density matrix in the coordinate representation, the Löwdin density matrices, the Dirac density matrix and other density matrices are traced. The roles of pure and mixed cases, equilibrium and nonequilibrium situations, and single- and many-body representations are considered. (auth)

**5052** LONG-TIME TRANSITION PROBABILITIES FOR A TWO-LEVEL SYSTEM INTERACTING WITH A STOCHASTIC ELECTROMAGNETIC FIELD. F. W. Cummings (Ford Motor Co., Newport Beach, Calif.). Am. J. Phys., 30: 898-901(Dec. 1962).

Solutions of Schrödinger's equations are demonstrated for a two-level quantum system which is coupled to a radiation field. The electric (or magnetic) field, which is considered as a definite (if unknown) function of time E(t), is characterized by a power spectrum or its related correlation function. Long-time transition probabilities are obtained in the form of a contour integral under the assumption of small atom-field coupling. The contour integral can be easily evaluated for many cases of interest. In particular, it is shown how a two level system in interaction with a blackbody approaches the Maxwell-Boltzmann distribution as $t \to \infty$. (auth)

**5053** ANNUAL REVIEW OF NUCLEAR SCIENCE. VOLUME 11. Emilio Segrè, ed. Palo Alto, California, Annual Reviews, Inc., 1961. 513p.

Twelve papers are included: separate abstracts have been prepared for 11. One paper was previously abstracted in NSA. Author and subject indexes are included for volumes 7 through 11 of the series. (T.F.H.)

**5054** STRONG INTERACTIONS AND REACTIONS OF HYPERONS AND HEAVY MESONS. G. Morpurgo (Università, Florence and Istituto Nazionale di Fisica Nucleare-Sottosezione, Florence). Ann. Rev. Nuclear Sci., 11: 41-94(1961).

Symmetry properties of strong interactions of K mesons and hyperons are reviewed, including: experimental attempts to determine the relative parities of the strange particles; analyses of parity conservation in strong interactions; and studies of various postulated symmetries for K-meson and hyperon interactions. Dynamical aspects of these interactions are also reviewed, with particular attention to the phenomenological treatment of $K^-$ low-energy reactions. A bibliography containing 167 references is included. (T.F.H.)

**5055** THEORIES OF NUCLEON-NUCLEON ELASTIC SCATTERING. Michael J. Moravcsik and H. Pierre Noyes (Univ. of California, Livermore). Ann. Rev. Nuclear Sci., 11: 95-174(1961). (UCRL-6388)

Results of phenomenological, meson-theoretical, and dispersion- and perturbation-theoretical analyses of the nucleon-nucleon interaction are reviewed and compared with experimental results. A bibliography containing 435 references is included. (T.F.H.)

**5056** NUCLEAR ORIENTATION. Louis D. Roberts and J. W. T. Dabbs (Oak Ridge National Lab., Tenn.). Ann. Rev. Nuclear Sci., 11: 175-212(1961).

Experimental and theoretical developments in dynamic and static methods for achieving nuclear orientation are reviewed. Results on several nuclei are noted. A bibliography containing 85 references is included. (T.F.H.)

**5057** SHIELDING OF HIGH-ENERGY ACCELERATORS. S. J. Lindenbaum (Brookhaven National Lab., Upton, N. Y.). Ann. Rev. Nuclear Sci., 11: 213-58(1961).

The occupational and non-occupational biological requirements for the shielding of accelerators in the several-hundred-Mev to several-Bev range are reviewed, as are the physical problems involved in making shielding calculations in this range. Cross sections for nucleons incident on common shielding materials (e.g., Pb, Cd, Cu, Al, C, Fe, concretes, and earth) are outlined where necessary for calculation purposes. Cross sections for n-p and p-p interactions are also discussed. Factors governing choices of shielding materials are noted. The shielding of the Cosmotron (3-Bev proton synchrotron) is detailed. A bibliography containing 51 references is included. (T.F.H.)

**5058** NEUTRON CAPTURE GAMMA RAYS. G. A. Bartholomew (Atomic Energy of Canada Ltd., Chalk River, Ont.). Ann. Rev. Nuclear Sci., 11: 259-302(1961).

A review is given of techniques and results of thermal- and epithermal-neutron-capture gamma-ray emission studies. The gamma emission mechanisms are discussed. A bibliography of 190 references is included. (T.F.H.)

**5059** NEUTRON DIFFRACTION. M. K. Wilkinson, E. O. Wollan, and W. C. Koehler (Oak Ridge National Lab., Tenn.). Ann. Rev. Nuclear Sci., 11: 303-48(1961).

A review is presented of the theoretical considerations, experimental apparatus and techniques, and applications of thermal-neutron diffraction studies. The applications considered include nuclear analyses, crystallography, chemical-bond studies, and magnetic property investigations. A bibliography containing 193 references is included. (T.F.H.)

**5060** NUCLEAR EFFECTS OF COSMIC RAYS IN METEORITES. James R. Arnold (Univ. of California, San Diego, La Jolla). Ann. Rev. Nuclear Sci., 11: 349-70(1961).

A review is presented of: the radiation and terrestrial ages of meteorites; orbits, shapes, and sizes of meteorites outside the earth's atmosphere; possible nuclear reactions in meteorites; and the analysis of meteorites to determine spatial and temporal variations of cosmic radiation intensity. A bibliography of 84 references is included. (T.F.H.)

**5061** DETECTION OF NUCLEAR EXPLOSIONS. R. Latter (RAND Corp., Santa Monica, Calif.), R. F. Herbst, and K. M. Watson. Ann. Rev. Nuclear Sci., 11: 371-418 (1961).

Concealment and detection of nuclear explosions in the atmosphere, underground, underwater, and in space are discussed. A bibliography containing 34 references is included. (T.F.H.)

**5062** HEAVY-ION ACCELERATORS. Edward L. Hubbard (Univ. of California, Berkeley). Ann. Rev. Nuclear Sci., 11: 419-38(1961). (UCRL-9600)

A review is presented of aspects of heavy-ion acceleration, including ion sources, electron stripping, types of accelerators (e.g., d-c high-voltage accelerators, cyclotrons, and linear accelerators), and possibilities for increasing currents and energies. A bibliography containing 68 references is included. (T.F.H.)

**5063** ISOTOPE EFFECTS IN CHEMICAL REACTIONS. Ralph E. Weston, Jr. (Brookhaven National Lab., Upton, N. Y.). Ann. Rev. Nuclear Sci., 11: 439-60(1961).

Isotopic mass differences result in alterations of molecular partition functions, and thus affect chemical reactions. A review is presented of secondary isotopic effects and of the effects of the use of $D_2O$ as a solvent in place of $H_2O$. A bibliography of 126 references is included. (T.F.H.)

**5064** INDUSTRIAL USES OF ISOTOPES. W. F. Libby (Univ. of California, Los Angeles). Ann. Rev. Nuclear Sci., 11: 461-82(1961).

The uses of radionuclides as tracers and labels, as sources for gaging thicknesses, and as radiation sources for various purposes (e.g., pest control, plant mutation, power plants, food preservation, and production of organic chemicals) are reviewed. Future uses are discussed. Regulatory and health limitations to these uses are noted. A bibliography containing 43 references is included. (T.F.H.)

**5065** CRYOGENICS. E. F. Hammel, W. E. Keller, and P. P. Craig (Los Alamos Scientific Lab., N. Mex.). Ann. Rev. Phys. Chem., 13: 281-304(1962). (TID-14594; LADC-5199)

Developments in the properties of liquid and solid $He^3$ and $He^4$ and in applications of the Mössbauer effect are discussed. The superfluid phase of liquid $He^3$ is discussed along with the properties of the liquid and solid along the melting line. Significant recent developments associated with the equilibrium thermodynamic properties of the condensed phases of $He^4$ and the thermohydrodynamics of liquid He II are outlined. Low-temperature applications of the Mössbauer effect in solid-state physics and magnetism are also given. 167 references are included. (P.C.H.)

**5066** ESTIMATION OF SOUNDING ROCKET TRAJECTORIES FROM TOTAL TIME OF FLIGHT. Charles T. Force (Sandia Corp., Albuquerque, N. Mex.). ARS (Am. Rocket Soc.) J., 32: 1095-7(July 1962). (TID-16423; SCDC-2488; SCR-529)

A technique is described which will permit a post flight estimation of the trajectory of a sounding rocket from a knowledge of the time duration of the flight. The basis of the technique is the postulation that the vertical motion is independent of the horizontal motion; this, in turn, is based on the assumption that the drag coefficient may be satisfactorily approximated by the reciprocal of the Mach number. It appears that the accuracies that are obtainable may eliminate the requirement for a tracking system in some instances. Potential applications are also noted for obtaining closed-form trajectory solutions and for analyzing actual trajectories to obtain performance parameters. The discussion is restricted to a specific application (including the accuracies that were obtained), and consequently no general conclusions are reached. (auth)

**5067** NUCLEAR POWER CHARGING OF THE RADIATION BELTS. R. P. Haviland (General Electric Co., Valley Forge, Penna.). ARS (Am. Rocket Soc.). J., 32: 1726(Nov. 1962).

It appears that operation of unshielded nuclear devices in space may result in appreciable increase in intensity of the trapped radiation belts. This would occur for neutrons that decay into protons within the belt regions and for alpha beta particles if they are emitted from the power source while it is in this region. An estimate of the change in belt intensity for decaying neutrons is given. (W.D.M.)

**5068** THE TRIODE CONCEPT OF DIRECT CONVERSION. James N. Anno, Jr. and Sherwood L. Fawcett. Battelle Tech. Rev., 11: No. 10, 3-9(Oct. 1962).

A direct-conversion cell is described in which the cathode is coated with a fissionable material and is separated from the anode by a negative-biased grid. When fissions occur in the fissionable coating, positively charged fragments at high energies and electrons at relatively low energies are emitted. The grid turns the electrons back toward the cathode, while allowing the positively charged (average charge = +21 e) ions to pass through to the anode. The positive potential of the anode is limited only by the dielectric breakdown characteristics of the cell, and may be on the order of several Mv. The cell may be used as an a-c generator by applying an alternating voltage to the grid. The use of banks of these cells as nuclear reactors is discussed for both stationary and space applications. It is noted that this system allows the kinetic energy of the fission fragments to be converted directly into electric energy without passing through the intermediate form of heat. (T.F.H.)

**5069** THE INTERPRETATION OF THE ANGULAR DISTRIBUTION OF GAMMA RAYS FROM ASSEMBLIES OF ORIENTED NUCLEI. J. M. Daniels (Univ. of Toronto) and J. M. Cotignola. Can. J. Phys., 40: 1342-59(Oct. 1962).

The problem of how to deduce, from the angular distribution of emitted $\gamma$-rays, the properties of a system in which radioactive nuclei are oriented is considered. A scheme is proposed for measuring an arbitrary angular distribution and for finding the axes which give the simplest description of this distribution. The permissible forms for the Hamiltonian of the nuclei are discussed. Relationships are deduced between the symmetries of the angular distribution of $\gamma$-rays, the crystal structure, and the various terms in the Hamiltonian. (auth)

**5070** STRUCTURE OF THE BAND SPECTRUM OF CuCl MOLECULE. IV. ROTATIONAL STRUCTURE OF THE D AND E SYSTEMS OF $Cu^{65}Cl^{35}$. P. Ramakoteswara Rao (Atomic Energy Establishment, Trombay, India), J. K. Brody, and R. K. Asundi. Can. J. Phys., 40: 1443-56(Oct. 1962).

The D and E band systems of $Cu^{65}Cl^{35}$, lying in the region 3900–4700 Å, have been photographed in emission under high resolution and rotational analysis of the (3,1), (2,0), (1,0), (0,0), and (0,1) bands of the D system and the (4,1), (3,0), (2,0), (1,0), (0,0), and (0,1) bands of the E system have been made. It has been assumed in the analysis that the D and E systems involve transitions $^1\Pi$ (D $^1\Pi$)–X $^1\Sigma$ and $^1\Sigma$ (E $^1\Sigma$)–X $^1\Sigma$ respectively. Fairly large $\Lambda$-doubling is observed in the D $^1\Pi$ state. Certain features in the E(0,0) band, which are not well understood, have been pointed out. The principal molecular constants obtained for the initial states of the D and E systems of $Cu^{65}Cl^{35}$ are given. (auth)

**5071** CALCULATION OF THE STRUCTURE OF THE $S_1(0)$ AND $S_1(0) + S_1(0)$ LINES IN THE INFRARED SPECTRUM OF SOLID HYDROGEN. H. P. Gush and J. Van Kranendonk (Univ. of Toronto). Can. J. Phys., 40: 1461-79(Oct. 1962).

At low ortho concentrations, the satellites appearing in the $S_1(0)$ infrared absorption feature of solid hydrogen arise from transitions in para molecules possessing one nearest-neighboring ortho molecule. The 15-fold degeneracy of the combination of the $v = 1$, $J = 2$ excited state of the para molecule and the $v = 0$, $J = 1$ ground state of the ortho molecule is partially lifted by the quadrupole–quadrupole interaction between the two molecules. The calculated structure of the $S_1(0)$ line is in good over-all agreement with the observed profile. The agreement is improved by taking into account the quadrupole–hexadecapole interaction. The best fit is obtained for a positive value of the hexadecapole moment of about 1.2 atomic units. The fine structure of the $S_1(0) + S_1(0)$ line in the overtone region of pure parahydrogen, resulting from the splitting of the 25-fold degeneracy of the upper state by the combined quadrupole–quadrupole and quadrupole–hexadecapole interaction, is also calculated. The splitting and relative intensity of the two components of the resulting doublet structure are in close agreement with the experimental values. All the calculations are performed assuming a rigid close-packed hexagonal lattice structure. The discrepancy of about 20% between the theoretical values of the quadrupole moment of a hydrogen molecule in the $v = 0$ and $v = 1$ states and the empirical values deduced from the analysis of the $S_1(0)$ and $S_1(0) + S_1(0)$ lines may be due to the neglect of the splittings arising from the coupling between the rotational motions of the molecules and the lattice vibrations. (auth)

**5072** CONDUCTIVITY OF ELECTRONS IN GASES WEAKLY IONIZED BY X RAYS. J. A. Carruthers (McGill Univ., Montreal). Can. J. Phys., 40: 1528-36(Nov. 1962).

Results are reported for oxygen and air at 1 to 10 mm Hg pressure irradiated by 100-kvp x rays at about 4300 roentgens/hour. Measurement of both terms of the complex conductivity of the gas at 50 Mc/s by a bridge technique, with modulation of the x-ray source at 120 c/s, gives data on the collision frequency $\nu$, the electron density n, and the dependence of collision frequency on the electron energy u ev. The limit of sensitivity is about one electron per cc. For dry air the data agree well with recent drift tube results by Pack and Phelps represented by $\nu(u) = 1.38 \times 10^{-7}$ N(air) u sec$^{-1}$, where N(air) is the air density in molecules/cc. For $O_2$ fair agreement with $\nu(u) = 7 \times 10^{-8}$ N($O_2$)u sec$^{-1}$ is observed, but the power of u may be greater than unity. The electron densities are consistent with three-body attachment of the electrons to neutral $O_2$ molecule with the coefficient $2.8 \times 10^{-30}$ cm$^6$/sec reported by Chanin et al., for thermal electrons. (auth)

**5073** THE RAMAN SPECTRUM OF ETHANE-$d_6$. D. W. Lepard, D. M. C. Swenney, and H. L. Welsh (Univ. of Toronto). Can. J. Phys., 40: 1567-82(Nov. 1962).

The Raman spectrum of $C_2D_6$ at 1 atm pressure was photographed with a spectral resolution of ~0.4 cm$^{-1}$. Of the six Raman-active fundamentals, $\nu_1$, $\nu_2$, $\nu_3$, $\nu_{10}$, and $\nu_{11}$ were observed, and the rotational structures of $\nu_2$, $\nu_3$, and $\nu_{10}$ were analyzed. The structure of $\nu_{10}$ confirms the $D_{3d}$ model for the molecule and the analysis gave $A_0 = 1.3416$ cm$^{-1}$. This value, along with recent infrared values of $B_0$ for $C_2H_6$ and $C_2D_6$, gives $r_0(C-H) \equiv r_0(C-D) = 1.0914 \pm 0.0003$ Å, $r_0(C-C) = 1.5362 \pm 0.0005$ Å, and $\angle HCH \equiv \angle DCD = 108.01 \pm 0.06°$. (auth)

**5074** SOME COMMENTS ON THE STATISTICAL MECHANICS OF IRREVERSIBLE PROCESSES IN GASES. R. Balescu (Université Brussels). Can. J. Phys., 40: 1664-9(Nov. 1962).

The objections formulated by Wu against the theory of irreversible processes developed by Prigogine and the author are discussed and shown to be incorrect. (auth)

**5075** REMARKS IN THE STATISTICAL MECHANICS OF IRREVERSIBLE PROCESSES IN GASES. T. Y. Wu (National Research Council, Ottawa). Can. J. Phys., 40: 1686-7(Nov. 1962).

A few brief remarks are made on the criticism by Balescu of Wu's comments about certain points in the work of Prigogine and of Balescu. (W.D.M.)

**5076** A NEW METHOD PERMITTING THE PRODUCTION OF A BEAM OF POLARIZED PARTICLES. Anatole Abragam and Jacques-Michel Winter. Compt. Rend., 255: 1099-1101(Aug. 6, 1962). (In French)

A method permitting the production of polarized protons is described. This method uses a Stern-Gerlach magnetic separation and an adiabatic passage transition in a region of low magnetic field. The method permits 100% polarization of a proton beam and 66% of a deuteron beam using a relatively simple experimental apparatus. (tr-auth)

**5077** THE THEORY OF THIN FLANGES IN MAGNETOHYDRODYNAMICS. Lazare Dragos (Universite, Bucharest). Compt. Rend., 255: 1289-90(Aug. 27, 1962). (In French)

The case of the orthogonal magnetic field at infinity with current velocity ($\underline{n}_2 = 0$, $\underline{n}_2 = 1$) is considered. (tr-auth)

**5078** NEW IONOSPHERE MEASUREMENT TECHNIQUE: PLASMA FREQUENCY PROBE. Obed C. Haycock and Kay D. Baker (Univ. of Utah, Salt Lake City). Electronics, 35: No. 48, 81-3(Nov. 30, 1962).

Recently a technique has been developed that directly measures the plasma frequency of an ionized medium from which the electron density can be calculated. The probe measures the plasma frequency of the ionosphere. Circuits for the probe are shown schematically and measurements made on a particular rocket flight are given. (W.D.M.)

**5079** SHALLOW DONOR THERMIONIC EMITTER. John K. Gorman (Sperry Gyroscope Co., Great Neck, N. Y.). J. Appl. Phys., 33: 3170-7(Nov. 1962).

A possible approach to the development of a low work function thermionic emitter involves the introduction of shallow donor states into a matrix having a low electron affinity. It is the intent of this paper to explore the concept of a shallow donor emitter from both a general point of view and with specific application to barium oxide as the host lattice. The problem is discussed in terms of the single-donor model with consideration given the various characteristics which would be required for a practical matrix-additive system. Although the electron affinity of BaO has been estimated to be as low as 0.6 ev, the ordinary oxygen vacancy donor present is a deep level with an ionization energy of about 1.4 ev; it yields a work function of 1.4 to 1.5 ev at 1000°K. By comparison, a work function of 0.83 ev would be expected for shallow donor BaO at this temperature. The substitution of a tripositive rare-earth ion for a $Ba^{2+}$ ion in the lattice is presented as a possible mechanism for the incorporation of an impurity donor center. Some speculation is offered concerning the ionization energy of this type of donor as well as the associated activation process. An attempt was made to observe the donor behavior of several rare-earth ion additives in BaO and also SrO by studying the temperature dependence of the effective work function. Data were secured for La, Gd, Nd, Er, and Eu in BaO, and Eu and Sm in SrO at analytical concentrations of from 0.01 to 0.05 mole %. While no lowering of the work function is reported, it is clear that no definitive interpretation of a negative result can be made until certain other experimental information becomes available, particularly the solubility and oxidation state of the additive ion in the matrix crystal. (auth)

**5080** THEORY OF GALVANO-THERMOMAGNETIC ENERGY CONVERSION DEVICES. I. GENERATORS. T. C. Harman and J. M. Honig (Massachusetts Inst. of Tech., Lexington). J. Appl. Phys., 33: 3178-88(Nov. 1962).

Using phenomenological equations in partially inverted form, the operation of galvano-thermomagnetic generators has been analyzed for six different modes of operation. The efficiency, figure of merit, and geometry optimization have been investigated. The two-dimensional temperature distribution prevailing in a device arm is also briefly analyzed. For the "longitudinal" case where heat flow and current are colinear in a transverse field, $H_z$, the mathematical relations conform to the standard theory, except that the transport coefficients depend on $H_z$. In the "transverse" case where heat flow, current, and magnetic field are mutually perpendicular, new expressions are obtained for the figure of merit and device efficiency. Furthermore, in the latter case the optimal operating conditions are those in which both device arms are made of the same material. The results are discussed in the light of some existing experimental data. (auth)

**5081** THEORY OF GALVANO-THERMOMAGNETIC ENERGY CONVERSION DEVICES. II. REFRIGERATORS AND HEAT PUMPS. T. C. Harman and J. M. Honig (Massachusetts Inst. of Tech., Lexington). J. Appl. Phys., 33: 3188-94(Nov. 1962).

Following the procedure of (Part I) the maximum temperature difference, coefficient of performance, figure of merit, optimum current and voltage, and the optimization conditions were obtained for galvano-thermomagnetic refrigerators and heat pumps under a variety of operating conditions. It is shown that the coefficients of performance of refrigerators and heat pumps differ by unity. Upper bounds are placed on the transverse figure of merit and a brief discussion of the main features of the theory is given. (auth)

**5082** OBSERVATION OF SELF-DECORATED FISSION TRACKS IN AgCl CRYSTALS. D. R. Turpe and T. G. Knorr (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys., 33: 3257-9(Nov. 1962).

Fission recoil fragments have been observed to produce tracks in AgCl crystals by a process of self-decoration. The decorated regions were studied with transmission optical microscopy and found to have diameters ranging in size up to 5000 Å. Correlation studies indicate that all of the fragments that entered the crystal produced observable regions. Fission tracks have been followed for about 11 $\mu$. (auth)

**5083** ZERO-FIELD EMISSION FROM THERMIONIC HOLLOW CATHODES. I. Brodie and A. Niewold (Westinghouse Electric Corp., Elmira, N. Y.). J. Appl. Phys., 33: 3328-34(Nov. 1962).

An examination of the theory of the thermionic hollow cathode shows that several distinct modes of zero-field emission are possible. The mode that exists in any given case depends on the relationship between a certain parameter d, which characterizes the nature of the electron cloud within the cavity, and the size of the effusion hole and the cavity dimensions. A quantitative expression is given for the conditions under which the hollow cathode can be used for a precise determination of the thermionic constants by the method of Jain and Krishnan. Under other conditions a quasi-hollow beam is obtained and a theoretical prediction of the total zero-field current from the hole was found to be in order of magnitude agreement with experimental observations. An explanation of the similarity of emissions between "L" cathodes of different porosity is also given. (auth)

**5084** SUPERCONDUCTORS AS PERMANENT MAGNETS. C. P. Bean and Margaret V. Doyle (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 33: 3334-7(Nov. 1962).

A discussion is given concerning the properties of superconductors considered as permanent magnets. Experiments on solid and hollow cylinders of lead are reported and compared to theoretical predictions. A macroscopic theory is developed of the filamentary mesh high-field superconductor in the form of an infinite plate. An experiment on a sample of $Nb_3Sn$ shows maximum energy product greater than 25 MG-Oe at 4.2°K. The phenomenon of discontinuous flux jumping is demonstrated and discussed briefly. (auth)

**5085** ENERGY SPECTRUM OF FISSION FRAGMENTS EMITTED FROM THIN LAYERS OF URANIUM DIOXIDE. R. F. Redmond, R. W. Klingensmith, and J. N. Anno (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys., 33: 3383-5(Nov. 1962).

Measurements were made of the fission-fragment energy spectrum from thin layers of $UO_2$ using gold-silicon surface barrier detectors, and the results were compared with calculations. The $UO_2$ coatings were deposited on Al tubes. (W.D.M.)

**5086** POWER DENSITY OF OPTIMALLY FOCUSED SPACE-CHARGE-LIMITED ELECTRON BEAMS. Helmut Schwarz (United Aircraft Corp., Windsor Locks, Conn.). J. Appl. Phys., 33: 3464-70(Dec. 1962).

Factors affecting the power density of optimally bundled electron beams used for the welding, cutting, and machining of solid materials are described. The power density and spot size of these beams are expressed as a function of acceleration voltage, beam current, and electron optical characteristics of the system. Assuming that the spherical aberration of the beam-focusing lens system limits the spot size of the space-charge-limited beam, the power density under optimum conditions increases approximately with the fifth power of the acceleration voltage, and decreases with the 7/4 power of the beam current. A criterion is also given to determine whether the electron beam at its impact on the workpiece is space-charge-limited. Some considerations are given to the neutralization of the electron space charge by ions originating from the background pressure of the vacuum system. (auth)

**5087** EMISSION OF NEGATIVE IONS FROM METAL SURFACES BOMBARDED BY POSITIVE CESIUM IONS. Victor E. Krohn, Jr. (Space Technology Labs., Inc., Redondo Beach, Calif.). J. Appl. Phys., 33: 3523-5(Dec. 1962).

High yields (>1%) of negative metal ions, usually including clusters of metal atoms and oxides, are observed from targets of Cu, Ag, Au, Be, Cd, Al, Sn, Ta, W, and Ni bombarded by a beam of positive cesium ions. The increase observed in the negative-ion yields when an auxiliary beam of neutral cesium is directed at a copper target indicates that the presence of cesium on the target is an important factor in the production of large numbers of negative ions. From targets of aluminum and tin, respectively, the $Al_2^-$ and $Sn_2^-$ yields are an order of magnitude greater than the corresponding single-atom yields. (auth)

**5088** ENERGY OBTAINABLE FROM A CARNOT ENGINE WITH A THERMALLY IONIZED GAS AS THE WORKING FLUID. M. H. Dunn and A. Maitland (C. A. Parsons and Co., Ltd., Newcastle-upon-Tyne, Eng.). J. Appl. Phys., 33: 3598-9(Dec. 1962).

A magnetoplasmadynamic generator is considered that uses a closed-cycle seeded gas as the working fluid. It is shown that if the generator is operated as a Carnot engine, the existence of ionization in the gas leads to an increase in the work obtained over that obtained using an un-ionized gas. (T.F.H.)

**5089** SPUTTERING EXPERIMENTS WITH 1- TO 5-kev $Ar^+$ IONS. A. L. Southern, William R. Willis, and Mark T. Robinson (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 34: 153-63(Jan. 1963).

Sputtering yields have been determined with 1- to 5-kev $Ar^+$ ions normally incident upon targets of type 304 stainless steel, three different types of polycrystalline Cu, a wide variety of Cu monocrystals, and monocrystals of Si and Ge. Ejection patterns have been recorded from these targets and from a monocrystal of InSb. The sputtering yield of polycrystalline Cu depends on the source of the metal, apparently due to variations in preferred orientation. The yield from Cu monocrystals is strongly dependent on orientation, the effect becoming more pronounced as the energy is increased. A simple model is presented which accounts for this behavior in terms of the variation with direction of the initial mean free path of the incident ion. The ejection patterns leave little doubt that focusing collision chains are primarily responsible for the transport of momentum to the surfaces of close-packed metals. (auth)

**5090** EXTREMA IN VELOCITY DEPENDENCE OF TOTAL ELASTIC CROSS SECTIONS FOR ATOMIC BEAM SCATTERING: RELATION TO DI-ATOM BOUND STATES.

Richard B. Bernstein (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 37: 1880-1(Oct. 15, 1962).

A relation between the maxima in Q(v) and the number of stable di-atom bound states and a procedure for evaluating the potential from the extrema velocities are given. A single, static, central potential was assumed. The principles of the treatment are general and are applicable to any realistic potential [long-range inverse power ($s \geq 3$) attraction, steep short-range repulsion]; for the purpose of concise illustration, however, the LJ 12-6 potential was used. Applying the procedure to the data, values for $10^{22}\,\epsilon\sigma$ (erg cm) of 9.4 and 6.7 were obtained for Li–Xe and K–Xe, respectively. Indexing of the extrema observed so far implies a minimum of three vibrational states each for the LiXe and KXe molecules in the $^2\Sigma^+$ state. (P.C.H.)

**5091** SOLAR FLARE X-RAY BURST ON SEPTEMBER 28, 1961. K. A. Anderson (Univ. of California, Berkeley) and J. R. Winckler. J. Geophys. Res., 67: 4103-17(Oct. 1962).

The bright chromospheric flare of September 28, 1961, emitted a burst of X rays observed by high-altitude balloon-borne detectors. The burst had a small precursor, a very rapid rise, and a three-component decay. The main part of the burst is therefore interpreted as being made up of three separate pulses. The x-ray burst shows two remarkable associations with the flare's radio noise emission: (1) microwave bursts at the highest radio frequencies coincide precisely in time with the precursor and the main peak; and (2) groups of type III bursts occur at or near the time of discontinuities in the decay of the X-ray burst and thus are associated with the leading edges of the three energetic electron pulses whose bremsstrahlung constitutes the observed X-ray flux. The appearance of both type III radiation originating in the corona at about $10^5$ km and bremsstrahlung X rays that cannot reasonably be produced above roughly 5000-km height in the chromosphere gives strong evidence that energetic electrons undergo large-scale motions in the solar atmosphere during chromospheric flares. For this particular flare a filamentary structure appears to be rooted near the sunspot where the flare occurs. Although no direct observations exist on this point, the filament no doubt extends up into the lower corona perhaps to heights of $10^5$ km. This leads to the possibility that the electrons are contained and guided by this structure. The photon energy spectrum is found to be nearly constant in form, whereas the X-ray intensity varies greatly. This fact makes it extremely unlikely that the bremsstrahlung originates from a thermal distribution of high-temperature electrons. A detailed analysis of the spectral time variation shows that the solar electrons must spend most of their time above the 15,000-km level. (auth)

**5092** COSMIC NOISE ABSORPTION ACCOMPANYING GEOMAGNETIC STORM SUDDEN COMMENCEMENTS. J. Ortner (Kiruna Geophysical Observatory, Sweden), B. Hultqvist, R. R. Brown, T. R. Hartz, O. Holt, B. Landmark, J. L. Hook, and H. Leinbach. J. Geophys. Res., 67: 4169-86(Oct. 1962).

Cosmic noise absorption coinciding with the sudden commencement of geomagnetic storms has been studied for 71 SC events from the data recorded at 25 riometer stations at or near the auroral zone during the period July 1958–December 1960. The greatest absorption was registered at stations near the central line of the auroral zone. The effect was observed simultaneously on the day and on the night side of the earth. This type of absorption was earlier found to be associated with bremsstrahlung X rays created by electrons entering the lower ionosphere. The source of these electrons has not been definitely established by the present study. Although the data tends to favor a source outside the earth's magnetosphere, no definite conclusion is possible because of the present uncertainties concerning the trapped radiation belts. (auth)

**5093** OXYGEN ISOTOPE STUDIES ON THE ORIGIN OF TEKTITES. Hugh P. Taylor, Jr. (Pennsylvania State Univ., University Park) and Samuel Epstein. J. Geophys. Res., 67: 4485-90(Oct. 1962).

$O^{18}/O^{16}$ ratios of thirteen tektites from Czechoslovakia, Libya, Texas, Indochina, Philippine Islands, Australia, Java, and Peru have been determined by the fluorine-extraction technique. All but one of these lie in relatively restricted range of $O^{18}/O^{16}$ ratio, with $\delta = 9.6$ to 10.4 per mil relative to the ocean-water standard. Tektites are therefore 0.5 to 1.5 per mil heavier than average granitic igneous rocks or about the same as average igneous quartz. The sample from Macusan, Peru ($\delta = 12.0$), is anomalous and is probably not a true tektite. Six analyzed shales are isotopically heavier than tektites and show a much wider range in values ($\delta = 14.2$, 14.8, 15.3, 15.5, 17.6, 18.2). Several detrital sedimentary rocks previously analyzed by Silverman and the present authors have $\delta$ values of 10.2 to 15.5; analyzed metasedimentary rocks have $\delta$ values of 12.1 to 15.7 per mil. Therefore, tektites are not sedimentary or metasedimentary material fused by lightning or by impact of an astronomical body with the earth. Chemically, tektites are unlike terrestrial igneous rocks, and their oxygen isotopic composition is unlike that of sedimentary or metasedimentary rocks. They therefore may be extraterrestrial objects. (auth)

**5094** INVESTIGATION OF COLOR CENTERS IN FLUORITE WITH APPLICATION TO GEOLOGIC TIME. Spencer R. Titley and Paul E. Damon (Univ. of Arizona, Tucson). J. Geophys. Res., 67: 4491-5(Oct. 1962).

A study of the ultraviolet absorption spectrums of fluorite has indicated a strong absorption band at 3050 A. The degree of absorption varies considerably with different fluorites and is ascribed to a variable concentration of defects in the crystal structure. Przibram and others have suggested that similar defects in halite, possible F centers, may be the result of radioactive damage. The fluorites examined during this study contain a low level of radioactivity, usually less than 1 ppm uranium equivalent. The 3050-A defect density, per unit radiation dose, appears to be a direct function of the age of fluorites. Infrared and visible absorption spectrums have also been investigated. (auth)

**5095** A PROPOSED ELECTROSTATIC ACCELERATION MECHANISM IN THE UPPER ATMOSPHERE AND ITS BEARING ON THE HELIUM PROBLEM. A. T. Wilson (Victoria Univ. of Wellington, N. Z.). J. Geophys. Res., 67: 4501-2(Oct. 1962).

From estimates of the release into the atmosphere of $He^4$ and the production rate of $He^3$, together with the directly measured concentration present, it is concluded that $He^3$ and $He^4$ have equal residence times. Considerations of thermal escape rates and existing concentrations are incompatible with equal residence times for $He^3$ and $He^4$. An alternative escape mechanism is suggested. (W.D.M.)

**5096** ANOMALOUS $U^{234}/U^{238}$ IN NATURE. David L. Thurber (Columbia Univ., Palisades, N. Y.). J. Geophys. Res., 67: 4518-20(Oct. 1962).

Recently, several workers, reported radioactive disequilibrium in nature between $U^{234}$ and its parent $U^{238}$. This anomaly may be used as a geochemical tool in the study of the behavior of U in rocks, soils, and natural waters. Samples of unraninite and Mississippian limestone in which $U^{234}$ was expected to be in equilibrium with $U^{238}$ were analyzed. Preliminary values for the oceans are given. Several samples from Eniwetok and Lake Bonneville were analyzed. (W.D.M.)

**5097** BORON IN METEORITES. M. Shima (Univ. of California, San Diego). J. Geophys. Res., 67: 4521-3(Oct. 1962).

The content and isotopic abundance of boron in meteorites are of interest because of the significance of boron in nuclear synthesis theories. Work based on $Na_2BO_2^+$ emission from borax on a tungsten filament is described. The values of $B^{11}/B^{10}$ ratio for meteorites (3.8 to 3.9) are lower than the terrestrial values (4.0 to 4.2). Boron contents in meteorites are around 0.4 to 0.5 ppm. (W.D.M.)

**5098** RADIOACTIVITY INDUCED IN DISCOVERER 17 BY SOLAR-FLARE PROTONS. James E. Keith and Anthony L. Turkevich (Univ. of Chicago). J. Geophys. Res., 67: 4525-32(Nov. 1962).

A sheet of lead 7 mm thick, part of the recovered United States Satellite Discoverer 17, has been examined for evidence of bombardment by solar protons while the satellite was in a polar orbit (November 12-14, 1960) during a class $3^+$ solar flare. Bismuth 205 from the reactions $Pb^{206}(p,2n)Bi^{205}$, $Pb^{207}(p,3n)Bi^{205}$, and $Pb^{208}(p,4n)Bi^{205}$ has been isolated by radiochemical techniques from 100-gram quantities of the lead and counted by x-ray gamma coincidence scintillation spectroscopy. The radioactivity at the time of recovery was about 1000 dpm of $Bi^{205}$ per kilogram of lead. Known cross sections for the nuclear reactions involved lead to an integrated omnidirectional flux above 57 Mev of $5.7 \times 10^8$ protons/cm$^2$. The energy spectrum of the protons is deduced from the variation in depth of the $Bi^{205}$ radioactivity. The exponent in the inverse-power-law differential energy spectrum is between 5 and 6. (auth)

**5099** THE ELECTROMAGNETIC SIGNAL DUE TO THE INTERACTION OF NUCLEAR EXPLOSIONS WITH THE EARTH'S MAGNETIC FIELD. W. J. Karzas and R. Latter (RAND Corp., Santa Monica, Calif.). J. Geophys. Res., 67: 4635-40(Nov. 1962).

There are two mechanisms by which the earth's magnetic field affects the electromagnetic signal from a nuclear explosion in the atmosphere. First, the Compton recoil electrons generated in the air by explosion $\gamma$ rays interact with the earth's magnetic field producing a 'back' field that tends to cancel the earth's field in the region near the explosion. Such a cancellation is equivalent to radiation from a magnetic dipole. Approximate calculations described indicate that this 'back' field is small at sea level, but increases with altitude. The other mechanism is that the earth's field is perturbed by the blast wave motion of heated (conducting) air. Calculations indicate that this mechanism produces a substantial effect, and its magnitude is crudely estimated. (auth)

**5100** MESH SIZE EFFECTS IN ALPHA-PARTICLE BACKSCATTERING. Neil A. Eskind and Hans Mark (Univ. of California, Berkeley). J. Geophys. Res., 67: 4867-72 (Nov. 1962).

Alpha-particle backscattering is a familiar technique for determining the elemental composition of surfaces. In the present work, the effect of the surface structure of the sample is investigated. It is found that the spectrum of the backscattered $\alpha$ particles depends on the surface structure; hence, the ability to resolve different nuclear species in the sample by this method depends on the nature of the surface. If the linear dimension of the surface structure is of the same order of magnitude as the $\alpha$-particle range in the material, a significant change in the spectrum of backscattered $\alpha$ particles is observed. For surface structures much larger or much smaller than the $\alpha$-particle range, normal spectrums are observed. (auth)

**5101** VERY-LOW-FREQUENCY PHASE OBSERVATIONS ON THE IONOSPHERIC EFFECTS OF THE SOLAR FLARE OF SEPTEMBER 28, 1961. A. G. Jean and J. H. Crary (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 67: 4903-5(Nov. 1962).

Abnormal phase variations observed at very low frequency during the class $3^+$ solar flare proton event of September 28, 1961, are discussed. The enhancement of solar x radiation was observed at a height of about 30 km by balloon-supported detectors. The propagation paths over which the VLF phase observations were made are shown. The paths are listed and the experimental results are summarized. (W.D.M.)

**5102** PHOTOIONIZATION IN THE F REGION. O. Burkard (Universität, Graz, Austria). J. Geophys. Res., 67: 4921-2(Nov. 1962).

Data were recently presented on the rate of photoionization on the basis of already extant measurements of absorption cross sections, particle densities, and solar spectrum intensities. An interesting result is obtained by investigating the electron concentration in the F region. Using N(h) profiles it is possible to determine not only the course of temperature with reference to altitude but also the absorption of the ionizing radiation. Transmission curves are obtained thus showing the decrease of energy of the entering radiation during its passage through the absorbing gas. (W.D.M.)

**5103** GEOMAGNETIC MICROPULSATIONS FROM THE HIGH-ALTITUDE NUCLEAR EXPLOSION ABOVE JOHNSTON ISLAND. B. J. Fraser (Univ. of Canterbury, Christchurch, N. Z.). J. Geophys. Res., 67: 4926(Nov. 1962).

Equipment to record geomagnetic micropulsations was in operation 15 miles from Christchurch, at the time of the high-altitude thermonuclear explosion over Johnston Island on July 9, 1962. Vertical component variations of the earth's magnetic field were measured by use of a buried loop feeding to a gavanometer and photocell unit followed by a broad-band amplifier. Overall response of the system was from direct current to 2.0 cps. Magnetic field changes of large magnitude were observed. (W.D.M.)

**5104** MAGNETIC DISTURBANCE FROM A HIGH-ALTITUDE NUCLEAR EXPLOSION. R. C. Baker and W. M. Strome (National Research Council, Ottawa). J. Geophys. Res., 67: 4927-8(Nov. 1962).

A few seconds after the reported time of a nuclear explosion over Johnston Island on July 9, 1962, a magnetic disturbance was recorded on two magnetometers at Ottawa. Records of the magnetometers are shown along with an estimate of the magnetic field during the disturbance. (W.D.M.)

**5105** MAGNETIC EFFECTS OF A HIGH-ALTITUDE NUCLEAR EXPLOSION. R. R. Unterberger and P. Edward Byerly (California Research Corp., La Habra). J. Geophys. Res., 67: 4929-32(Nov. 1962).

The results of two magnetometer recordings of the geomagnetic disturbance caused by the July 9, 1962, thermonuclear explosion at 200 km over Johnston Island are presented. A comparison is made with recordings of the 1959 Teak and Orange shots. (W.D.M.)

**5106** OBSERVATIONS OF THE CHANGES IN THE EARTH'S MAGNETIC FIELD INDUCED BY THE HIGH-ALTITUDE NUCLEAR EXPLOSION OF JULY 9, 1962. Edward V. Ashburn, James P. Lee, and Ray N. Francis (Naval Ordnance Test Station, China Lake, Calif.). J. Geophys. Res., 67: 4933-4(Nov. 1962).

The July 9, 1962, Johnston Island detonation produced a measurable change in the geomagnetic field at China Lake for a period of about 30 seconds. The first detected change occurred 1.5 sec after zero countdown. Field changes were detected by two large 20000 turn air core coils buried horizontally and vertically. Signal recordings from the coils are shown. (W.D.M.)

**5107** GENERATION OF HORIZONTALLY POLARIZED SHEAR WAVES BY UNDERGROUND EXPLOSIONS. M. J. Randall (Seismological Observatory, Wellington, N. Z.). J. Geophys. Res., 67: 4956-7(Nov. 1962).

From an analysis of the propagation of compressional and SH waves from underground explosions Wright and Carpenter (J. Geophys. Res., 67: 1956(1962)) concluded that there is a mode of SH waves which attenuates much more slowly near the source than does the compressional wave, and that this accounts for the prominence of recorded shear waves. It is suggested that their result appears to arise from errors in the analysis. These errors are discussed. (W.D.M.)

**5108** A MOLECULAR-ORBITAL APPROACH TO THE DEVELOPMENT OF VIBRATIONAL POTENTIAL FUNCTIONS: CO FORCE CONSTANT AND STRETCH-STRETCH INTERACTION CONSTANTS FOR METAL HEXACARBONYLS. Llewellyn H. Jones (Los Alamos Scientific Lab., N. Mex.). J. Mol. Spectr., 9: 130-7(1962). (TID-14800; LADC-5216)

From a consideration of the molecular-orbitals of carbon monoxide it is shown that the observed CO force constants of the metal carbonyls indicate considerable metal-carbon pi bonding. The seven stretch-stretch interaction constants of the metal hexacarbonyls of octahedral symmetry are reduced to three constants using a molecular-orbital development. The results are the same as those derived using a valence-bond approach. (auth)

**5109** ISOTOPE SHIFT IN THE SPECTRUM OF MERCURY HYDRIDE. Terence L. Porter and Sumner P. Davis (Univ. of California, Berkeley). J. Opt. Soc. Am., 52: 1206-8(Nov. 1962).

The isotope shift in the HgH spectrum for $Hg^{198}H-Hg^{200}H$ was measured for 698 lines in the $A\,^2\Pi - X\,^2\Sigma^+$ system. The variation of the isotope shift with rotational frequency of the line is different for the various branches of a band, and greatly exceeds the variation predicted by the usual rotational and vibrational mass effects alone. This phenomenon is a consequence of the different nuclear volumes of the mercury isotopes. The results are evidence that the total electron probability density at the mercury nucleus increases with rotational frequency at a faster rate for the ground state than for the excited state. (auth)

**5110** DISCRIMINATION OF CHARGED PARTICLES OF DIFFERENT MASSES BY AN IMPROVED METHOD OF GRAIN-COUNTING. Mikio Yamanouchi (Tokyo Univ. of Education). J. Phys. Soc. Japan, 17: 1523-6(Oct. 1962).

In place of the usual method of grain counting in which all the silver grains in a certain length from the end of a track are counted, a new method has been developed by counting only the grains excepting those in the last fifty microns of the track, since near the end of a track the apparent number of grains is not proportional to the energy loss. The ratio of the average number of grains in equal lengths of track-segments of deuterons and protons was found to be as high as 1.28 ± 0.03, in contrast to the values ranging from 1.10 to 1.17 hitherto reported. The method has been applied to the discrimination of photodeuterons from photoprotons. (auth)

**5111** MÖSSBAUER STUDY OF HYPERFINE FIELD, QUADRUPOLE INTERACTION, AND ISOMER SHIFT OF $Fe^{57}$ IN $FeS_{1.00}$, $FeS_{1.05}$ AND $FeS_{1.07}$. Kazuo Ono (Tokyo Univ.), Atsuko Ito, and Eiji Hirahara. J. Phys. Soc. Japan, 17: 1615-20(Oct. 1962).

The hyperfine structures of $Fe^{57}$ in $FeS_{1.00}$, $FeS_{1.05}$, and $FeS_{1.07}$ have been investigated by the method of the Mössbauer absorption. The extrapolated values of the magnetic fields at the iron nuclei in $FeS_{1.00}$, $FeS_{1.05}$, and $FeS_{1.07}$ are 328 kOe, 318 kOe, and 324 kOe at 0°K respectively. The energy shifts due to the quadrupole interaction in $FeS_{1.05}$ at 290°K and 90°K have opposite sign and their ratio is −2.8. The corresponding ratio in $FeS_{1.07}$ is −2.0. This indicates that the antiferromagnetic easy axis changes by 90° through the transition temperature from the c axis, which is considered as the direction of the largest electric field gradient, onto the c plane, while direction and value of the electric field gradient remain unchanged. Observed internal magnetic fields, quadrupole coupling constants, and isomer shifts at various temperatures are given. (auth)

**5112** LUMINESCENCE OF X-RAYED ALKALI HALIDE CRYSTAL INDUCED BY PLASTIC DEFORMATION. Masayasu Ueta, Masaki Kojima, and Masamitsu Hirai (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 17: 1668-9(Oct. 1962).

If both the transient electric conductivity increase and the luminescence induced by plastic deformation are ascribed to the motion of dislocation there should be some similarity between the decays of current and luminescence. Curves of decays of transient current and luminescence in KCl and NaCl crystals at room temperature are shown. (W.D.M.)

**5113** NUCLEAR MAGNETIC RESONANCE OF $Fe^{57}$ IN LITHIUM FERRITE AND MAGNETITE. Shizuko Ogawa, Setsu Morimoto, and Yoshiko Kimura (Ochanomizu Univ., Tokyo). J. Phys. Soc. Japan, 17: 1671-2(Oct. 1962).

Nuclear magnetic resonance of $Fe^{57}$ in lithium ferrite $Li_{0.5}Fe_{2.5}O_4$ in an ordered state was observed with a frequency modulated spectrometer operated at a low power level. Second derivative of absorption versus frequency exhibited two strong lines and two weak lines. A sample quenched from high temperature exhibited resonances although the intensity was decreased. The x-ray diffraction of this sample showed weak superstructure lines which indicates a residual ordering. (W.D.M.)

**5114** EVOLUTION OF THE DENSITY MATRIX OF LARGE SYSTEMS. Lesser Blum (Facultad de Ciencias Exactas y Naturales, Buenos Aires). J. Phys. Soc. Japan, 17: 1689-93(Nov. 1962). (In English)

The time dependent perturbation series for the density matrix is shown to be equivalent to an integral equation. This integral equation is given in the form of a series in the coupling parameter $\lambda$, which is always convergent when $t \to \infty$. The terms of this series can be represented by time retarded operators. (auth)

**5115** SATELLITE OBSERVATIONS OF THE ENERGETIC PARTICLE FLUX PRODUCED BY THE HIGH-ALTITUDE NUCLEAR EXPLOSION OF JULY 9, 1962. A. C. Durney, R. J. Hynds, and J. J. Quenby (Imperial Coll. of Science and Tech., London). Nature, 195: 1245-8 (Sept. 29, 1962).

A megaton nuclear explosion occurred at 0900h 15s u.t.

on July 9, 1962, at an altitude of about 320 km in the vicinity of Johnston Island. A preliminary analysis is presented of data on the energetic particle flux produced above the atmosphere. The data were obtained by means of a Geiger counter equipped with special circuits carried in the satellite Ariel. A chronological plot is presented of the intensity recorded by the Geiger counter for the period 0800 u.t. to 2200 u.t. on July 9. The data present evidence of the redistribution of the mirror points of the naturally occurring electrons in the outer radiation belt, an additional population of electrons that remained trapped in the geomagnetic field, and a low-altitude shell of fission product decay electrons formed over the Pacific Ocean, stretching westward from Johnston Island to the neighborhood of the Atlantic coast of the American continent. This shell lasted for more than a day and was continually supplied with electrons by the decay of charged fission fragments supported in the Earth's magnetic field in the neighborhood of Johnston Island. A considerable part of the additional radiation had disappeared by July 12 but the life-time of the trapped radiation cannot be predicted until the decay law is established. (C.H.)

**5116** DECAMETRIC WAVE-LENGTH ABSORPTION RESULTING FROM THE NUCLEAR DETONATION OF JULY 9, 1962. R. M. Straka, P. G. Elkins, and H. A. Strick (Air Force Cambridge Research Lab., South Hamilton, Mass.). Nature, 196: 156-7(Oct. 13, 1962).

Riometer data taken at the Air Force Cambridge Research Laboratories, Sagamore Hill Radio Observatory, in Hamilton, Massachusetts, showed a pronounced effect following the high-altitude nuclear detonation on July 9, 1962, at Johnston Island. Onset of the absorption occurred between H + 3 to H + 8 min., reached a maximum drop in signal-level at H + 21 min., and was essentially back to normal slightly less than an hour after the onset. No unusual solar activity was reported by other observatories on this date. Sagamore Hill is situated almost 39° geomagnetically north of Johnston Island, thus any trapped particles must have passed well to the south of this station as the sheath encircled the globe. This sheath appears to have been mainly responsible for the drop out of the propagated signals. Riometer data show that a true D-layer absorption occurred at this latitude. It is suggested that the D-layer absorption occurring at this high a latitude may be the result of prompt neutrons from the burst decaying into $\beta$ particles, which were then guided into the D-layer via magnetic field lines. (C.H.)

**5117** PRODUCING A NEUTRAL ATOMIC HYDROGEN BEAM. H. Roepke and H. Spehl (Universität, Freiburg i. B.). Nucl. Instr. Methods, 17: 169-70(Oct. 1962). (In German)

A neutral hydrogen beam was produced by splitting accelerated $H_2^+$ ions in a gas target. The percentage of neutral atoms is about 12% for $H_2^+$ energies from 1.4 to 4.6 Mev. Cross sections for the reactions $H_2^+ \rightarrow H^+ + H^0$ and $H_2^+ \rightarrow 2H^+ + e^-$ in argon are given. (auth)

**5118** ABSORPTION OF PHONONS BY AN ELECTRON GAS. S. Rodriguez and K. Tharmalingam (Princeton Univ., N. J.). Nuovo cimento (10), 26: 43-52(Oct. 1, 1962). (In English)

A study is made of the absorption of acoustic waves in metals considering the interaction of the motion of the ions of the crystal with the plasma formed by the conduction electrons. The attenuation of the sound waves is expressed in terms of the imaginary part of the dielectric constant for longitudinal waves and of the imaginary part of the magnetic permeability for transverse waves. Expressions for both situations are found. (auth)

**5119** ON THE INTERNAL ENERGY AND PARTITION FUNCTION OF A BOSE SYSTEM. V. Canuto (Università, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo cimento (10), 26: 140-9(Oct. 1, 1962). (In English)

A weakly interacting Boson system is considered. Fradkin's formula for the internal energy is deduced and explicit calculation is made for propagators. The final energy spectrum allows us to conclude that in this system, or, in the region of validity of the Hartree approximation for the two-body propagator, cannot exist terms linear in momentum k. (The phonon part of Landau spectrum). Calculation of the partition function for the same system of bosons is performed, when the temperature is not too low. (auth)

**5120** A NOTE CONCERNING THE SPIN OF THE PHONON. A. D. Levine (Wayne State Univ., Detroit). Nuovo cimento (10), 26: 190-3(Oct. 1, 1962). (In English)

Work being conducted on the quantization of the phonon field using the Lagrangian formalism is reported. Results for waves propagating in isotropic media are extended to the case of phonon fields in lattices. All calculations are carried out in the continuum limit. (W.D.M.)

**5121** RELATIVISTIC INVARIANCE AND THE TACIT UNIQUENESS POSTULATE IN QUANTUM FIELD THEORY. R. L. Ingraham (New Mexico State Univ., University Park). Nuovo cimento (10), 26: 328-41(Oct. 16, 1962). (In English)

The relativity principle for quantum fields is dissociated from a uniqueness assumption heretofore always made in quantum field theory. There appear to be no compelling experimental or theoretical reasons to impose this tacit postulate. If it is given up, time-dependent unitary equivalence of interacting and a free field is no longer forbidden. (auth)

**5122** NOTE ON THE DIFFUSION COEFFICIENT IN MIXTURES OF $^3$He IN HELIUM II. M. Vicentini-Missoni (Università, Rome). Nuovo cimento (10), 26: 575-80 (Nov. 1, 1962). (In English)

The data on the diffusion in mixtures of $He^3$ in helium II obtained by Garwin and Reich with the spin echo technique are analyzed in the light of the theory of Khalatnikov and Zharkov. It is seen that the experimental data follow the theory in the temperature range $1.1°K < T < 1.3°K$ giving a value of the roton's activation energy in agreement with the neutron diffraction data. The value of the cross section $He^3$-rotons is also calculated as $\sigma_{ir} = 2.0 \times 10^{-14}$ cm$^2$. (auth)

**5123** INTERNAL COMPTON EFFECT. E. Fuschini, C. Maroni, and P. Veronesi (Università, Bologna). Nuovo Cimento (10), 26: 831-9(Nov. 16, 1962). (In English)

An experimental check on the internal Compton effect is presented. The experiment, performed using a $Ba^{137}$ source, consists of the measurement of the differential cross section of the effect at 30°, 45°, 60°, 90°, 120°, 150°, and 180° angles. The results are in satisfactory agreement with the theoretical calculation of Spruch and Goertzel. (auth)

**5124** THE EFFECT OF NUCLEAR QUADRUPOLE MOMENTS ON FORBIDDEN TRANSITIONS IN HYDROGENLIKE ATOMS. L. A. Borisoglebskii. Opt. Spectry. (USSR) (English Transl.), 13: 1-5(July 1962).

Selection rules are established and a calculation made in a nonrelativistic approximation of the probabilities of forbidden transitions induced by quadrupole interaction between the nucleus and the orbital electrons of hydrogen-like atoms. (auth)

**5125** RELAXATION LUMINESCENCE SPECTRA OF URANIUM ACTIVATED ALKALI AND ALKALI EARTH

METAL FLUORIDES. N. A. Tolstoi and Shun-fu Liu. Opt. Spectry. (USSR) (English Transl.), 13: 59-61(July 1962).

Development of the pulse taumeter, which enabled the relaxation properties of luminescence to be studied with great sensitivity, made it possible to measure the relaxation time of individual, even relatively weak, lines of the luminescence spectra of uranium activated alkali and alkali earth metal fluorides. Preliminary data are presented on the relaxation spectra of samples of $CaF_2-U$, $SrF_2-U$, $BaF_2-U$, $LiF-U$, and $NaF-U$. (W.D.M.)

**5126** THE ELECTRODYNAMICS OF MAGNETO-ELECTRIC MEDIA. T. H. O'Dell (University Coll., Ibadan, Africa). Phil. Mag., (8), 7: 1653-69(Oct. 1962).

A general magneto-electric medium is one in which there is a linear, reciprocal relationship between the magnetic field and the electric polarization, and between the electric field and the magnetic polarization, as well as a linear relationship between the magnetic field and the magnetic polarization and between the electric field and electric polarization. The relationship between the fields and polarizations is expressed by means of a single tensor equation relating the field and polarization tensors in the medium. The properties of the rank four susceptibility tensor, required to establish this relationship, are investigated. A general tensor wave equation is obtained for a homogeneous anisotropic medium. The equation to the wave-vector surface is obtained as a six-by-six determinant, which must vanish, and which gives results in agreement with experiment when applied to simple anisotropic dielectric or magnetic crystals. When this equation is applied to an ideal magneto-electric medium, in which the magnetic and electric susceptibilities may be neglected, the conclusion is reached that waves of constant amplitude cannot propagate in a magneto-electric medium. If propagation takes place at all the waves must have either positive or negative damping, as a result of an exchange of energy between waves having perpendicular planes of polarization. (auth)

**5127** STABILITY OF STEP SHOCKS. Jerome J. Erpenbeck (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 5: 1181-7(Oct. 1962). (TID-15179)

The hydrodynamic stability of a steady, plane, step shock through a fluid medium with arbitrary equation of state is investigated through consideration of the initial-value problem for the time-dependent hydrodynamic equations, linearized in perturbations from the steady flow. If the stability function, $F_s = 1 + \kappa - \kappa^2(\nu_1 - \nu)\ p_s/T$ (with $\kappa$ the Mach number, $\nu$ the specific volume, T the absolute temperature, $p_s$ the entropy derivative of pressure at constant volume, and subscript 1 referring to the preshock state) is negative, disturbances grow exponentially with time and the shock is unstable. The character of the shock Hugoniot with respect to stability is discussed. (auth)

**5128** EXCHANGE OF ENERGY BETWEEN GASES AT DIFFERENT TEMPERATURES. Edward A. Desloge (Florida State Univ., Tallahassee). Phys. Fluids, 5: 1223-5(Oct. 1962).

An expression for the energy exchange between two Maxwellian gases at different temperatures is derived. The resultant formula contains an integral in which the scattering cross section for momentum transfer appears. If the cross section for hard-sphere collisions is used, the expression reduces to an expression obtained by Cravath for this case. If the cross section for screened Coulomb interactions is used, the results agree with results for the same case obtained by Spitzer and others. (auth)

**5129** MOMENT EQUATIONS AND BOUNDARY CONDITIONS FOR MAGNETO-GAS DYNAMICS. H. T. Yang (Univ. of Southern California, Los Angeles). Phys. Fluids, 5: 1580-9(Dec. 1962).

Moment equations are obtained from the Boltzmann equation for a conducting gas in electric and magnetic fields. Relatively simple stress and heat-flux equations yielding one-fluid description of a slightly ionized gas mixture are obtained. The associated boundary conditions are obtained by applying conservation laws near the wall. These moment equations and boundary conditions, together with Maxwell's electromagnetic equations and their boundary conditions, form a determinate system to describe the dynamics of a rarefied conducting gas in electric and magnetic fields. This system includes, as limiting cases, both the thirteen-moment equations for rarefied gases and the continuum magneto-gas-dynamic equations. (auth)

**5130** SIMILARITY SOLUTION FOR CYLINDRICAL MAGNETOHYDRODYNAMIC BLAST WAVES. Carl Greifinger (RAND Corp., Santa Monica, Calif.) and Julian D. Cole. Phys. Fluids, 5: 1597-1607(Dec. 1962).

A similarity solution is obtained for the flow behind a very strong (in the hydrodynamic sense) cylindrical magnetohydrodynamic shock wave produced by the sudden release of energy along a line of infinite extent in a plasma. The plasma is assumed to be an ideal gas with infinite electrical conductivity, and to be permeated by the azimuthal magnetic field of a line current. It is shown that it is of critical importance to take into account the ambient magnetic pressure, no matter how small. It is found that, to preserve similarity, the external circuit is required to maintain a constant axial current; this result also appears in the related problem in which the ambient plasma is nonconducting. This boundary condition is shown to have consequences regarding the energy content of the system. The dependence of the shock speed on the explosive energy is determined as a function of the ambient magnetic field both for conducting and nonconducting plasma, and differences are noted. Other differences between the two cases are also discussed. (auth)

**5131** RATE OF IONIZATION BEHIND SHOCK WAVES IN AIR. I. EXPERIMENTAL RESULTS. Shao-Chi Lin, Richard A. Neal, and Walter I. Fyfe (Avco-Everett Research Lab., Everett, Mass.). Phys. Fluids, 5: 1633-48 (Dec. 1962).

The electron density profile behind normal shock waves in air at initial pressures $0.02 \le p_1 \le 0.2$ mm Hg and in the shock-Mach-number range $14 \le M_s \le 20$ is measured, using microwave-reflection and magnetic-induction probes in a 24-in.-diameter shock tube. It is found that the electron density generally rises rapidly behind the shock front without much incubation to a transient peak value that is considerably higher (i.e., by a factor of between 2 and 3) than that corresponding to the final equilibrium value. At a fixed shock Mach number, the maximum electron density gradient behind the shock appears to vary with the square of the initial air density, indicating that all the important rate-governing steps are caused by binary collisions. Thus, at $M_s = 20$, the distance behind the shock required to reach 90% of the transient peak electron density is found to be about 10 times the viscosity mean free path of the undisturbed gas ahead of the shock. At $M_s = 14$, the corresponding distance is found to be approximately 40 times the initial mean free path. (auth)

**5132** THERMAL AND RADIATIVE PROPERTIES OF RECOMBINING ATOMIC NITROGEN. Thomas Marshall and R. A. Kawcyn (Univ. of Illinois, Urbana). Phys. Fluids, 5: 1657-60(Dec. 1962).

Experiments on phenomena associated with the atomic recombination of nitrogen atoms are discussed. The temperature dependence of the three-body rate coefficient is found to be proportional to $T^{-0.6}$ over the temperature range of 200 to 400°K. The absolute photon production rate accompanying the atomic recombination in the Rayleigh afterglow is measured and found to be about one photon per 200 recombinations. The experiments rely on an electron spin resonance technique to measure the absolute atomic nitrogen density, and permit a rough determination of the dissociation energy of nitrogen. (auth)

**5133** ANOMALOUS LIQUID-SOLID TRANSFORMATION OF HELIUM-THREE. L. Goldstein and R. L. Mills (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 128: 2479-86(Dec. 15, 1962). (LADC-5364)

A study was made of the anomalous liquid-solid phase transformation of $He^3$. By allowing the phase boundary lines of the liquid and solid volumes to have singular pressure derivatives, the melting pressure minimum and the boundary volume line maximas of the liquid and solid occur at two different temperatures. This leads to smooth variations of the anomalous isobars and isochores of the liquid, insuring a single minimum to the isobaric expansion coefficients, in qualitative agreement with data available at the present time. The transformation of a normal family of isotherms into an anomalous one, and vice versa, either on a phase transformation or within a pure phase will be clarified. The geometry of the state surface, on the basis of the stated assumptions, will be shown to justify the existence of thermal anomalies of the cubic solid $He^3$ over a finite extension of this phase well beyond its boundary line. (auth)

**5134** ANALYSIS OF NUCLEAR MAGNETIC RESONANCE LINE SHAPES BY LATTICE HARMONICS. D. E. O'Reilly and Tung Tsang (Argonne National Lab., Ill.). Phys. Rev., 128: 2639-54(Dec. 15, 1962). (TID-16918)

The second ($M_2$) and fourth ($M_4$) moments of magnetic resonance absorption lines of nuclei in crystals resulting from dipolar and exchange interactions have been given by Van Vleck. The dependence of $M_2$ and $M_4$ on the orientation of the magnetic field in the crystal coordinate system may be rewritten in terms of lattice harmonics of the crystal point group. Only lattice harmonics belonging to the identity representation occur. The number of such functions, and hence the number of independent quantities needed to specify $M_2$ and $M_4$ have been determined for all 32 point groups. These numbers vary from 15 and 45 for triclinic $C_1$ symmetry to 2 and 4 for cubic $O_h$ symmetry. $M_2$ and $M_4$ are given as a finite series of lattice harmonics of the crystal orientation, the coefficients of which are expressed as irreducible lattice sums. Application is made to available data on the resonance of $F^{19}$ in $CaF_2$, $Al^{27}$ in aluminum metal and $H^1$ in urea, $CO(NH_2)_2$; the effect of lattice vibrations on the moments of $CaF_2$ and Al are examined. The influence of an applied electric field of NMR moments and the use of lattice harmonics in other spectroscopics of the solid state are considered. (auth)

**5135** L-SHELL FLUORESCENCE YIELDS OF Pt, Tl, AND Pb. R. C. Jopson, Hans Mark, and C. D. Swift (Univ. of California, Livermore). Phys. Rev., 128: 2671-5 (Dec. 15, 1962). (UCRL-6944)

Partial L-shell fluorescence yields for three heavy elements have been measured using an x-ray coincidence counting method. Vacancies in the K shell of the atom are produced either by K-electron capture or internal conversion of a nuclear gamma ray in the K shell. The coincidence rate between the K and L x rays observed after the creation of the K vacancy determines the partial fluorescence yield, $\omega_{KL}$. This quantity is defined as the fluorescence yield of those vacancies in the L shell created by $K_{\alpha_1}$ and $K_{\alpha_2}$ x-ray emission. In some cases, it was also possible to determine the partial fluorescence yield, $\omega_{LL}$ of the L shell following L-electron capture. The results obtained are in reasonable agreement with previous measurements. The relationship between $\omega_{KL}$, $\omega_{LL}$, and the fluorescence yields of individual L subshells is discussed. (auth)

**5136** COLLISION CROSS SECTION OF SLOW ELECTRONS AND IONS WITH CESIUM ATOMS. C. L. Chen and M. Raether (Univ. of Illinois, Urbana). Phys. Rev., 128: 2679-83(Dec. 15, 1962).

Microwave interferometry is adopted to measure the effective-collision cross section for momentum transfer $\overline{Q}_m$ of thermal electrons (of mean energies ~0.06 to 0.071 ev) with cesium atoms in the afterglow of pure cesium and helium-cesium discharges. The momentum-transfer cross section $\overline{Q}_m$ is found to be best represented by $1.61 \times 10^{-10} T_e^{-1} - 9.63 \times 10^{-12} T_e^{-1/2} + 2.03 \times 10^{-13}$ $cm^2$ in the temperature range of approximately 450 to 550°K. The energy dependence of the elastic electron-cesium-atom collision probability for momentum transfer is determined to be $P_m = 997\ u^{-1} - 4810\ u^{-1/2} + 7230\ cm^{-1}$, where u is the energy of the electron volts. This shows a smooth tendency to join Brode's data at higher electron energies. Mobilities of $Cs^+$ ions in helium and in cesium have been determined from the helium-cesium mixture experiments in the same temperature range. They are $\mu(Cs^+ \text{ in He}) = 18.5 \pm 0.5$ $cm^2$/V-sec and $\mu(Cs^+ \text{ in Cs}) = 0.4 \pm 0.05$ $cm^2$/V-sec referred to standard gas density (i.e., $2.69 \times 10^{19}/cm^3$). (auth)

**5137** COHERENT SCATTERING OF PHOTONS BY ATOMIC HYDROGEN. M. H. Mittleman and Fred A. Wolf (Univ. of California, Livermore). Phys. Rev., 128: 2686-7 (Dec. 15, 1962). (UCRL-6897-T)

The cross section for the coherent scattering of light by atomic hydrogen is evaluated numerically below the first excitation threshold. The evaluation above threshold is discussed. (auth)

**5138** TUNNELING INTO SUPERCONDUCTORS. John Bardeen (Univ. of Illinois, Urbana). Phys. Rev. Letters, 9: 147-9(Aug. 15, 1962).

The tunneling of electrons through a thin insulating layer between a normal and a superconducting metal is discussed. A previous derivation is examined to bring out the connection with the semiconductor model of a superconductor, and the quasi-particle excitations in normal and superconducting states are discussed. (H.D.R.)

**5139** SUPERCONDUCTING TRANSITION TEMPERATURE OF SUPERIMPOSED FILMS OF TIN AND SILVER. W. A. Simmons and D. H. Douglass, Jr. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 9: 153-5 (Aug. 15, 1962).

The depression of the transition temperature of thin films of Sn by thin films of Ag and Co has been measured. Specimens were prepared in a vacuum by evaporating films of Sn onto a glass slide and then evaporating Ag or Co films onto the Sn. The transition temperatures were determined by measuring the resistance when cooled. The theoretical explanation of the data is discussed for both nonmagnetic and ferromagnetic metals. (H.D.R.)

**5140** PHENOMENOLOGICAL THEORY OF SUPERIMPOSED FILMS OF NORMAL AND SUPERCONDUCTING METALS. D. H. Douglass, Jr. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 9: 155-9(Aug. 15, 1962).

A phenomenological thermodynamic model is presented to explain the properties of superimposed films of superconducting and normal metals. The properties of the combination of metals are developed in terms of the properties of the pure constituents. A general theory is described in which the concept of a "superconducting state" of a normal metal is introduced. The free-energy density of normal metals and superconductors is discussed for varying conditions. Two film thicknesses are examined with respect to transition temperature variations. (H.D.R.)

**5141** TEMPERATURE DEPENDENCE OF A TRANSVERSE OPTIC MODE IN STRONTIUM TITANATE. R. A. Cowley (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. Letters, 9: 159-61(Aug. 15, 1962).

Strontium titanate exhibits a large static dielectric constant with a temperature dependence that follows the curie-law above 70°K. The lowest frequency transverse optic branch associated with this dielectric constant, propagating in the [100] direction of a single crystal of strontium titanate, has been studied by the inelastic scattering of slow neutrons. The dispersion curve is observed to be most temperature dependent at long wavelengths but almost independent of temperature at the zone boundary. The temperature dependence of the long wavelength mode is in good agreement with theory. Plots of neutron groups are given for three different temperatures using the constant momentum transfer method for the lattice vibrations with the reduced wave vector, $\vec{q}$, at zero. The frequency of the $\vec{q} = 0$ mode is tabulated for fine temperatures and compared to frequencies deduced from the far infrared reflectivity. (H.D.R.)

**5142** DIRECT AND DISSOCIATIVE IONIZATION CROSS SECTIONS FOR ELECTRONS IN $N_2$. C. J. Cook and J. R. Peterson (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev. Letters, 9: 164-6(Aug. 15, 1962).

Cross sections for single ionization and for combined dissociative and double ionization of $N_2$ by electron impact were measured using a crossed-beam technique. The data obtained are analyzed, and the dissociative ionization processes are discussed. It is concluded that dissociative ionization is not likely to result from a single interaction at electron energies less than about 45 ev. A probable explanation of the sizable $N^+$ currents found below 40 ev in mass spectrometers is given. (H.D.R.)

**5143** FOURTH SOUND IN He II. I. Rudnick and K. A. Shapiro (Univ. of California, Los Angeles). Phys. Rev. Letters, 9: 191-3(Sept. 1, 1962).

Experimental results are presented to verify the existence of the unattenuated mode of wave propagation in helium II known as fourth sound. The experimental apparatus and procedure are described. A plot is given of the measured values of the fourth sound velocity from 1.19 to 2.1°K. For comparison the calculated curves of first and fourth sounds are given over the same temperature range. A brief discussion is given of the significance of the results. (H.D.R.)

**5144** EXISTENCE OF MINIMA IN THE MELTING CURVES OF $He^3-He^4$ MIXTURES. H. Weinstock, F. P. Lipschultz, C. F. Kellers, P. M. Tedrow, and D. M. Lee (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 9: 193-5(Sept. 1, 1962).

Measurements were made on the melting curves of $He^3-He^4$ mixtures in the temperature region below 1°K. Descriptions are given of the strain-gauge and sample chamber used in the experiment. The results are plotted and indicate that the melting curves of a 25 mole % $He^3-75$ mole % $He^4$ mixture and a 38 mole % $He^3-62$ mole % $He^4$ mixture have minima in the neighborhood of 0.8°K. Melting-curve measurements on pure $He^4$ and $He^3$ are shown for comparison. Features of the results are discussed, and it is concluded that the existence of melting-curve minima in $He^3-He^4$ mixtures indicates an ordering in the liquid mixtures at rather high temperatures. (H.D.R.)

**5145** PHASE SEPARATION IN SOLID $He^3-He^4$ MIXTURES, AS SHOWN BY SPECIFIC HEAT MEASUREMENTS. D. O. Edwards, A. S. McWilliams, and J. G. Daunt (Ohio State Univ., Columbus). Phys. Rev. Letters, 9: 195-7 (Sept. 1, 1962).

Specific heat measurements in the range 0.05 to 1°K are presented for solid $He^3-He^4$ mixtures over a range of concentrations to 80% $He^4$. The specific heat (C/R) is graphed versus temperature (T) for a number of values of the atomic fraction ($X_0$) of $He^3$. Also the phase separation line is plotted as T versus $X_0$ using a single adjustable parameter determined by fitting the specific-heat data to the theory. The results show that solid helium mixtures split into two nearly pure phases of $He^3$ and $He^4$ near O°K. (H.D.R.)

**5146** IMAGE OF THE FERMI SURFACE IN LEAD. Arthur Paskin and R. J. Weiss (Army Materials Research Agency, Watertown, Mass.). Phys. Rev. Letters, 9: 199-200(Sept. 1, 1962).

A search for Kohn anomalies, which arise from the electron-phonon interaction and manifest themselves as discontinuities in phonon dispersion curves, was made in lead by measuring the thermal diffuse scattering of x rays. Such anomalies have been observed in Pb using neutron inelastic scattering. Presented are x-ray intensity measurements which are in agreement with the neutron measurements and give further information not previously reported. The x-ray technique is concluded to be inferior to neutron techniques for observing Kohn anomalies in Pb because of the high absorption coefficient. This technique may prove to be the more efficient of the two for other materials. (H.D.R.)

**5147** SCREENING CORRECTION TO THE SLATER EXCHANGE POTENTIAL. J. E. Robinson (Argonne National Lab., Ill.), F. Bassani, R. S. Knox, and J. R. Schrieffer. Phys. Rev. Letters, 9: 215-16(Sept. 1, 1962).

The exchange potential in solids is approximated by a modification of the original Slater formula for a free-electron gas. The procedure, based on a uniform-electron-gas approximation for local regions, modifies the Slater calculation to include the influence of electron correlation on pair interactions and, therefore, decreases the potential sharply in regions of low density. Moreover, at nearly all densities this correlation introduces a correction factor sufficiently severe to make itself felt in any calculation in which the choice of exchange potential is important. The approximation consists, in effect, of replacing the Coulomb interaction $e^2/r_{12}$ in the original Slater treatment of exchange by $(e^2/r_{12} \times \exp(-k_s r_{12})$, where $K_s$ is an appropriate screening factor. (H.D.R.)

**5148** SLATER PARAMETERS FOR THE Hf III SPECTRUM. Mark Fred (Argonne National Lab., Ill.) and Th. A. M. Van Kleef. Physica, 28: 1007-10(Oct. 1962). (TID-14703) (In English)

The identifications of the levels previously reported for Hf III have been confirmed, except for a few minor interchanges, by conventional calculations. Tables of composition of the levels are given. (auth)

**5149** METASTABLE HELIUM ATOM CONCENTRATIONS IN THE EARTH'S ATMOSPHERE. E. E. Ferguson and H. Schlueter (Univ. of Texas, Austin). Planetary Space Sci., 9: 701-10(Oct. 1962).

Calculations of He($2^3S$) metastable concentrations in the earth's atmosphere by a previously suggested process involving photoexcitation by solar uv 584 and 537 Å is shown to yield only ~$5 \times 10^5$ metastables/cm$^2$ (column) under typical twilight conditions. This is far too small to account for recent Russian twilight glow observations of resonant scattered λ10830 Å. Radiative recombination is shown to be probably more important but still probably insufficient to account for observations. Direct excitation by photoelectrons seems to be the most likely operative metastable production mechanism. The processes of metastable destruction are considered in some detail. Cross sections for triplet metastable destruction by $O_2$ and $N_2$ molecules are 14 and $7 \times 10^{-16}$ cm$^2$, respectively, and it is estimated that the O atom cross-section is around $5 \times 10^{-16}$ cm$^2$. (auth)

**5150** APPLICATION OF THE MULTICHANNEL EFFECTIVE RANGE THEORY TO ELECTRON–HYDROGEN SCATTERING. R. Damburg and R. Peterkop (Inst. of Physics, Latvian Academy of Sciences, Riga). Proc. Phys. Soc. (London), 80: 1073-7(Nov. 1, 1962).

The behavior of cross sections in the neighborhood of the 2s excitation threshold is investigated using M matrix theory. Calculations allowing for 1s–2s strong coupling are carried out for zero angular momentum in singlet, triplet, and no-exchange cases. Threshold effects in all cases have the form of a cusp. A narrow resonance has been found below the threshold in the singlet case. (auth)

**5151** CONDUCTIVITIES FOR INHOMOGENEOUS ELECTRIC FIELDS IN SPACE AND TIME. Kazuo Yamada (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 28: 299-314(Aug. 1962). (In English)

The electron transport equation for conductors under electric fields which vary both in space and time is developed quantum-mechanically. The case where electrons are scattered elastically by static impurity centers and the case where scattered inelastically by phonons are treated separately. The equation derived has a new extra term, which represents the coupled effects of electron collisions with impurities or phonons and electron motions by the external oscillating fields. This term plays an important role in high frequency regions, though vanishes in the static limit. The conductivities in the static limit and in the high frequency limit are given from special solutions of this equation. (auth)

**5152** AN OBSERVATION IN QUANTUM MECHANICS. Saburo Amai (Univ. of Osaka Prefecture, Sakai, Japan). Progr. Theoret. Phys. (Kyoto), 28: 401-2(Aug. 1962). (In English)

An observation of a quantity A of a micro-system S carried out by reading the values of a quantity B of a measuring apparatus M is considered. The initial state of the total system (S + M) is $\Phi(\chi,r,o) = (c_1\psi_1(\chi) + c_2\psi_2(\chi) + \ldots)\Psi(r)$, where $\Psi_i$'s are eigenstates of A and $\Psi(r)$ is the initial state of M. (W.D.M.)

**5153** STUDY OF A FOCUSED BEAM FROM THE DUOPLASMATRON PROTON SOURCE. Richard McKeever and Akihiko Yokosawa (Argonne National Lab., Ill.). Rev. Sci. Instr., 33: 746-9(July 1962).

Aberrations of the preaccelerator focusing electrodes are studied experimentally by obtaining emittance diagrams for a beam of 38 and 60 ma. Aberrations observed are similar to those obtained from ray-tracing calculations. According to the calculations, the cause of aberrations is improper distribution of the radial field in the exit portion of the lens. More distortion of the phase-space diagram is observed for the higher beam current than for the lower one. The observed emittance area increases by more than a factor of two when the beam current is changed from 38 to 60 ma. Even if aberrations are entirely eliminated, this fact may raise a serious problem in beam matching for a large beam current. A technique for measuring the emittance of the beam at 200 kv is developed, and its details are described. (auth)

**5154** ENERGY SPECTRA OF SLOW POSITIVE RUBIDIUM AND CESIUM IONS SCATTERED BY A MOLYBDENUM SURFACE. V. I. Veksler (Lenin State Univ., Tashkent, USSR). Soviet Phys.-Solid State (English Transl.), 4: 1043-5(Dec. 1962).

To clarify the mechanism of interaction of atomic particles with the surface of a solid, the energy spectra of scattered $Rb^+$ and $Cs^+$ ions are studied with initial energies U = 15 to 250 ev, at a scattering angle of 120° by a molybdenum target at T = 1400 to 1450°K. (auth)

**5155** CORRELATION ENERGY AND COLLECTIVE EXCITATIONS FOR THE INTERACTING FERMI-FIELDS. A. V. Tulub. Vestnik Leningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 20-9(1962). (In Russian)

The collective excitation spectrum in the case of two interacting Fermi-fields is considered. The main approximation is the high density limit in which the correlation energy was calculated. (auth)

**5156** EXCHANGE IN THE ADIABATIC APPROXIMATION IN THE THEORY OF ATOM. M. G. Veselov and L. N. Labsovskii. Vestnik Leningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 30-5(1962). (In Russian)

An equation for the optical electron of univalent atoms was derived in adiabatic approximation. It implies exchange with the core electrons. An approximate expression for the exchange correction to the energy of the atom in the adiabatic approximation was obtained, and the correction was evaluated for the ground state of lithium. (auth)

**5157** THE FOCUSING OF CHARGED PARTICLES BY ONE STRAIGHT BOUNDARY OF HOMOGENEOUS MAGNETIC FIELD. V. R. Saulit. Vestnik Leningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 72-81(1962). (In Russian)

The focusing property of a homogeneous magnetic field, whose boundary is one straight line, is considered. (auth)

**5158** INVESTIGATION OF THE DEVELOPMENT OF CANAL DISCHARGES IN GASES. H. Schlumbohm (Universität Hamburg). Z. Physik, 170: 233-48(1962). (In German)

The temporal development of the current of a discharge leading to breakdown was investigated under static and homogeneous field conditions with wide band oscilloscopic techniques. The discharges were started by $10^3$ to $10^5$ electrons released within some $10^{-9}$ sec along traces of single α particles parallel to the electric field. Measurements showed that streamer mechanism occurs in gases as $CH_4$ and $CO_2$ at static breakdown, if a sufficient density of space charge is produced by a great number of overlapping avalanches. The gas amplification of the single avalanche only has a value of about $10^5$. Also in $O_2$ and dry air at high pd-values breakdown develops with streamer mechanism. In electronegative gases such as freon-12 and $O_2$ a prolongation of the time necessary for streamer formation is caused by the reduction of the effective total space charge by the negative ions. The results of a detailed study of the time necessary for streamer development and the time constant of the increase of the current leading to breakdown confirmed the model of streamer mechanism. (auth)

**5159** PHYSICAL ADSORPTION OF GASES. D. M. Young and A. D. Crowell. Washington, D. C., Butterworths, 1962. 434p. $13.00.

This book presents a review of the literature on physical adsorption since 1930, excluding complications such as capillary phenomena. The following items are discussed: adsorption forces, thermodynamics of adsorption, adsorption of monolayers and multilayers on uniform surfaces, estimation of surface areas by gas adsorption, adsorption on nonuniform surfaces, adsorption isotherms, adsorption calorimetry, properties of adsorbed layers, and adsorption of gas mixtures. (D.L.C.)

**5160** QUANTIZATION OF THE YANG-MILLS FIELD. Stuart Irwin Fickler. Thesis, Syracuse, N. Y., Syracuse Univ., 1962. 126p.

The Yang-Mills field, which is a theory of this non-linear, gauge-type, which lies between electrodynamics and general relativity in complexity was examined. The quantum Yang-Mills field is introduced as an auxiliary field which arises to satisfy the requirement of invariance under phase transformations of the second kind. The theory was then put into its first order form so as to make it amenable to quantization by the methods of the Schwinger Action Principle. Quantization was then carried out for two different gauge conditions, the first of which led to a perturbation treatment of the theory and the second to a rigorous treatment. It is shown that the conditions for a consistent quantization of the theory are satisfied for both cases to the order considered. An isotopic covariant derivative formalism analogous to that of Reimannian geometry was then introduced for both the classical and quantum case, and some of its ramifications are discussed. Finally, a number of problems which have evolved and which merit further investigation are discussed and suggestions concerning their approach are submitted. (Dissertation Abstr., 23: No. 4, 1962)

**5161** BEHAVIOR OF THE He II $n = 3 - 4$ LINE IN A HOLLOW CATHODE DISCHARGE. Frederick Lewis Roesler. Thesis, Madison, Wisc., Univ. of Wisconsin, 1962. 104p.

The fine structure of the He II $n = 3\text{-}4$ transition ($\sigma = 21335$ K, $\lambda = 4686$ Å) as observed in a hollow cathode cooled in a liquid nitrogen or liquid helium was studied with the aid of a photoelectric recording Fabry-Perot spectrometer employing two Fabry-Perots in series with a grating monochromater. The traces showed excellent resolution. Among the component lines: the relative intensities tend toward the calculated statistical intensities with increasing pressure in the discharge region, and toward relative intensities determined by the lifetime and rate of excitation of the initial state with decreasing pressure; the measured relative positions did not disagree with those calculated from quantum electrodynamics; the widths of the components were appreciably greater than the widths of the components of the He I line at $\sigma = 21218$ K, the widths being 87 mK and less than 50 mK respectively, in liquid He; and the positions were significantly shifted (~4 mK) due to a drift of the He$^+$ ions toward the cathode, and there was evidence that the lines of the neutral atoms were shifted (~1 mK) due to a motion of the emitters towards the anode. (Dissertation Abstr., 23: No. 4, 1962)

**5162** ELECTRON EMISSION CURRENT NUCLEAR REACTOR. Rainer Guenther. British Patent 909,989. Nov. 7, 1962.

The electron emission current nuclear reactor is designed to convert nuclear energy directly into an electrical current. A core containing fissionable material is in direct contact with the emitter electrode, which is electrically isolated from the collector electrode. (R.J.S.)

## Astrophysics and Cosmology

**5163** (ARL-TDR-62-2) RADIATION MEASUREMENTS WITH BALLOONS, 1961. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Apr. 1962. Contract AF29(600)-2361. 57p. (AD-275547)

A group of radiation detectors for monitoring solar-flare radiation in the upper atmosphere was prepared and flown on a series of balloon flights to altitudes of about 125,000 ft at Bemidji, Minnesota, during the summer of 1961. The instruments consisted of a scintillation telescope, two neutron detectors, and a shielded Geiger-counter monitor. The neutron counting rates observed in both neutron detectors as a function of altitude are compared for all flights. The neutron counting rates observed on a day of normal activity are compared with the neutron fluxes calculated assuming a source of neutrons produced only by primary cosmic rays interacting in the atmosphere. (auth)

**5164** USEFULNESS OF SOLAR OUTBURST PREDICTION. Bruce W. Shore (Analytic Services Inc., Bailey's Crossroads, Va.). ARS (Am. Rocket Soc.) J., 32: 1737-9 (Nov. 1962).

Because outbursts of charged particles from the sun constitute a major hazard for space flight, prediction of these events would be useful. An indication of the degree of usefulness may be gained by contrasting the "safe" flights possible under accurate prediction of each event with those possible under no prediction ability. This note presents such a contrast, based on observed solar activity from 1954 through 1961. (auth)

**5165** A MODEL OF THE INTERPLANETARY MEDIUM. John C. Brandt (Univ. of California, Berkeley). Icarus, 1: No. 1, 1-6(May 1962).

An empirical model of the interplanetary medium is constructed. Near the orbit of earth, we find an electron density of about $1/\text{cm}^3$ and an expansion velocity of about 200 km/sec. A high velocity "solar wind" seems to prevail for $0 \leq r \leq 2$ au, while a low velocity "solar breeze" seems to prevail beyond 2 au. This type of model is compared with other lines of evidence, and considerable agreement is found. (auth)

**5166** PHOTOELECTRIC SCREENING OF BODIES IN INTERPLANETARY SPACE. S. F. Singer and E. H. Walker (Univ. of Maryland, College Park). Icarus, 1: No. 1, 7-12(May 1962).

Bodies in space which are subject to the solar ultraviolet flux will emit photoelectrons. A certain number of these escape and are balanced by the accretion of thermal electrons from the surrounding plasma. However, for a positively charged body, a much larger number of photoelectrons will be released from the surface but will not escape because their energy is insufficient to do so. Their effect will be to produce an inner screening of the body's electric charge. This screening is calculated for spherical bodies as a function of size. For large bodies the space charge density of photoelectrons becomes quite large; in the case of the Moon it reaches a value of the order of $10^3$ to $10^4$ electrons/cm$^3$ just above the lunar surface. For small dust particles, however, the photoelectric cloud becomes negligible. (auth)

**5167** THE FORMATION OF THE SUN AND PLANETS. A. G. W. Cameron (Carnegie Inst. of Washington, D. C.; California Inst. of Tech., Pasadena; Atomic Energy of Canada Ltd., Chalk River, Ont.; and NASA Inst. for Space Studies, New York). Icarus, 1: No. 1, 13-69(May 1962).

The evidence concerning the presence of the products of extinct radioactivities in meteorites and in the atmosphere is reviewed and analyzed. Some mechanisms of nucleosynthesis are reviewed, and it is shown that the elements can be divided into products of primary and secondary processes. A model of the stellar activity throughout galactic history is devised, and its parameters are determined by the abundances of the U and Th isotopes. Some physical processes probably associated with the formation of the solar system are discussed. (W.D.M.)

**5168** IS THE MARTIAN BLUE HAZE PRODUCED BY SOLAR PROTONS? Carl Sagan (Univ. of California, Berkeley). Icarus, 1: No. 1, 70-4(May 1962).

The hypothesis that solar protons produce the Martian blue haze is examined. To reach the atmospheric depth at which the observed haze layer is localized, proton energies in excess of 2 Mev are required. In order to produce sufficient molecular ionization to obscure surface detail in the blue, the proton fluxes must be greater than $10^{11}$ $cm^{-2}$ $sec^{-1}$ at Mars. So that magnetic deflection of solar protons by the terrestrial magnetic field can explain the clearing of the blue haze which is observed at opposition, the interplanetary magnetic field strength must be less than $10^{-8}$ gauss. Recent observations argue strongly against these required interplanetary magnetic field strengths and solar proton energies and fluxes. Several further observational tests are suggested, but at the present time it appears that this hypothesis should be rejected. (auth)

**5169** HYDRODYNAMIC MODELS OF THE SOLAR CORONA. L. M. Noble and F. L. Scarf (Space Technology Labs., Los Angeles). J. Geophys. Res., 67: 4577-84(Nov. 1962).

Various hydrodynamic models of the solar corona are briefly considered. The hydrodynamic equations yield both fast solutions, in which the gas expands outward at supersonic speeds, and slow solutions, in which the expansion velocity vanishes asymptotically. It has previously been argued that some of the slow solutions give finite pressure at infinity and cannot, therefore, describe a stable configuration. It is shown, however, that the self-attraction of the expanding gas becomes significant asymptotically and serves to compress the gas and give zero pressure. Arguments are also given that indicate that the pressure may be anisotropic in the local rest frame of the expanding (or static) corona. The observed solar wind may be a manifestation of this anisotropy. (auth)

**5170** THEORETICAL MODELS FOR THE SOLAR-CYCLE VARIATION OF THE UPPER ATMOSPHERE. Isadore Harris and Wolfgang Priester (National Aeronautics and Space Administration, Greenbelt, Md. and Inst. for Space Studies, New York). J. Geophys. Res., 67: 4585-91(Nov. 1962).

Models of the upper atmosphere for different levels of solar activity have been calculated by solving the heat conduction equation under quasi-hydrostatic conditions by means of the procedure described in detail in a previous paper. In these calculations the fluxes of both heat sources (EUV and corpuscular heat source) are varied in proportion to the long term averages of the 10.7-cm solar fluxes in order to account for different levels of solar activity during the solar cycle. The resulting temperatures of the exosphere can be represented by $T_{min} = 4.5 \cdot S + 275$ (°K) and $T_{max} = 7.1 \cdot S + 372$ (°K) where $T_{min}$ and $T_{max}$ are the diurnal minimum and maximum temperatures respectively, and S is the monthly average of the 10.7-cm solar flux in units of $10^{-22}$ $w/m^2$ cps. The slope for $T_{min}$ is in good agreement with that found by L. G. Jacchia from analysis of satellite drag. The physical properties (temperature, density, scale height, and mean molecular weight) are illustrated as functions of local time and of altitudes between 120 and 2050 km for five different values of S. (auth)

**5171** ON THE CHRONOLOGY OF THE FORMATION OF THE SOLAR SYSTEM. 1. RADIOGENIC XENON 129 IN THE EARTH'S ATMOSPHERE. P. K. Kuroda and O. K. Manuel (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 67: 4859-62(Nov. 1962).

A method for the calculation of the total number of atoms of radiogenic $Xe^{129}$ in the earth's atmosphere is proposed. The atmosphere contains approximately $2.06 \times 10^{35}$ atoms of radiogenic $Xe^{129}$. This corresponds to 9.6% of the total atmosphere $Xe^{129}$ and leads to a maximum value of 240 million years for the time interval ($\Xi$) between the nucleosynthesis and the formation of the earth. (auth)

**5172** ON THE CHRONOLOGY OF THE FORMATION OF THE SOLAR SYSTEM. 2. IODINE IN TERRESTRIAL ROCKS AND THE XENON 129/136 FORMATION INTERVAL OF THE EARTH. P. K. Kuroda and W. H. Crouch, Jr. (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 67: 4863-6(Nov. 1962).

The iodine content of nine crustal rocks was determined by a spectrophotometric method. The iodine content ranged between 0.04 and 0.33 ppm, the average value being 0.16 ppm. A method for calculating the time interval ($\Xi$) between the nucleosynthesis and the formation of the earth from the ratio of radiogenic $Xe^{129}$ versus fissiogenic $Xe^{136}$ in the earth's atmosphere is proposed. The $Xe^{129}/Xe^{136}$ formation interval ($\Xi$) of the earth is calculated to be 102 million years. (auth)

**5173** FURTHER COMMENTS ON STABILITY OF INTERFACE BETWEEN SOLAR WIND AND GEOMAGNETIC FIELD. A. J. Dessler (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 67: 4892-4 (Nov. 1962).

It has been previously suggested that surface magnetometer data suggest that the interface between the solar wind and the magnetosphere is stable rather than turbulent as commonly assumed. It is shown that the introduction of the concept of a standing shock wave maintained by the solar wind impinging on the magnetosphere makes satellite and space-probe data consistent with the conclusion that the interface between the solar wind and the magnetosphere is stable. (W.D.M.)

**5174** CORRECTION TO THE SECOND APPROXIMATION CALCULATION OF THE GEOMAGNETIC FIELD, SOLAR WIND INTERFACE. David B. Beard and Edward B. Jenkins (National Aeronautics and Space Administration, Greenbelt, Md.). J. Geophys. Res., 67: 4895-6(Nov. 1962).

In reporting the second approximation calculation of the geomagnetic field solar wind interface (D. B. Beard, J. Geophys. Res., 67: 477-83(1962)) an error was in sign in equation 20 owing to a change in notation during the calculation. Effects of the correction on the calculation are detailed. (W.D.M.)

**5175** SOLAR TEMPERATURE AT 2-mm WAVELENGTH. D. J. H. Wort (United Kingdom Atomic Energy Authority, Culham, Eng.). Nature, 195: 1288-9(Sept. 29, 1962).

A harmonic-mixing superheterodyne radiometer that was developed for microwave diagnostics of Zeta was used together with a small radiotelescope for measuring the apparent temperature of the sun at a wavelength of 2.04 mm. The result obtained was $T_{sun} = 5{,}670 \pm 230$°K. (L.T.W.)

**5176** PULSATING UNIVERSE. Priyansu Sen Gupta (City Coll., Calcutta). Nuovo cimento (10), 26: 379-89 (Oct. 16, 1962). (In English)

The possibilities and the relativistic treatment of a pulsating model of the universe which is filled entirely by fluid are discussed. The stars and planets are enveloped by the fluid. (auth)

**5177** PHOTON DENSITY AND THE GAMMA-RAY FLUX AT A POINT IN AN EXPANDING UNIVERSE. G. C. McVittie (Univ. of Illinois Observatory, Urbana). Phys. Rev., 128: 2871-8(Dec. 15, 1962).

The investigation deals with certain cosmological questions involved in the interpretation of the gamma-ray flux measurements made by the satellite Explorer XI. An expanding universe filled with similar sources of optical radiation is considered and the photon density in the neighborhood of an observer is obtained. Numerical values are given for the density of 1-ev photons when the sources are regarded as blackbodies at a temperature of 5000°K. The necessity of specifying the bandwidth, the model of the universe, and the scale of distance before a density can be stated, is emphasized. The models of the universe considered are those of general relativity and that of the steady-state theory. It is concluded that a photon density can be specified, in the present state of astronomical knowledge, only as lying within wide limits. The gamma-ray flux observed can be interpreted theoretically by the use of general relativity models in which the density of matter is rather high. An equally satisfactory interpretation is possible by the use of the steady-state theory. It is argued that the objections to the second theory, based on the Explorer XI data, refer only to the hypothesis of the creation of antiprotons and not to the theory itself. (auth)

**5178** SOME SUGGESTED EXPERIMENTS RELEVANT TO THE PECULIAR STAR 3 CENTAURI AND RELATED OBJECTS. George Wallerstein (Univ. of California, Berkeley). Phys. Rev. Letters, 9: 143-4(Aug. 15, 1962).

A comparison of the composition of normal stars and 3 Centauri reveals that almost all the He$^4$ has been destroyed in 3 Centauri. The hypothesis is advanced that the He$^4$ is destroyed by energetic protons in the reaction He$^4$(p,d)He$^3$. Experiments are suggested to test this hypothesis and to determine the cross sections of the Si$^{28}$(p,d)Si$^{27}$($\beta^+$)Al$^{27}$ and S$^{32}$(p,d)S$^{31}$($\beta^+$)P$^{31}$ reactions. (H.D.R.)

## Cosmic Radiation

*Refer also to abstracts 4693 and 4708.*

**5179** (AFCRL-62-453) ASYMPTOTIC DIRECTIONS OF PRIMARY COSMIC-RAY PROTONS ARRIVING AT DURHAM AND MT. WASHINGTON, N. H. Scientific Report No. 10. M. A. Shea (New Hampshire. Univ., Durham). May 1962. Contract AF19(604)-4552. 20p. (AD-276508)

The asymptotic directions for particles of discrete rigidities detected at Mt. Washington and Durham, New Hampshire, are determined by calculating the trajectories of these particles in the geomagnetic field. From these results a lower cutoff rigidity of approximately 1.16 BV and 1.30 BV is assigned to Mt. Washington and Durham, respectively. The penumbra effect is discussed in relationship to the study of solar flare associated cosmic-ray increases. A FORTRAN program for converting geographic coordinates to geomagnetic coordinates using high-speed computers is also included. (auth)

**5180** CHANGES IN THE INTENSITY LEVEL OF COSMIC RAYS AT FOUR STATIONS IN CANADA. J. Katzman and D. C. Rose (National Research Council, Ottawa). Can. J. Phys., 40: 1319-31(Oct. 1962). (NRC-7001)

The mean annual intensity of the nucleon and meson components of the cosmic-ray intensity at Ottawa, Churchill, and Sulphur Mountain was at a minimum for the year September 1957 to August 1958 when the mean annual intensity of the 10.7-cm radio solar flux was at a maximum and the annual mean of the interplanetary magnetic index K$_p$ was at its first maximum since the low at the beginning of the present solar cycle. At Resolute Bay the mean annual intensity of the nucleon and meson components was at a minimum for the year July 1959 to June 1960 when the interplanetary magnetic index K$_p$ was at a second maximum. The anomalous behavior at Resolute Bay is attributed to a combination of spectral differences and directional effects. (auth)

**5181** RADIO AND CORPUSCULAR EMISSION ASSOCIATED WITH THE FLARE SURGE ON THE WESTERN LIMB OF THE SUN ON JULY 20, 1961. V. Gaizauskas (Dominion Observatory, Ottawa) and A. E. Covington. J. Geophys. Res., 67: 4119-23(Oct. 1962).

The small cosmic-ray increase of July 20, 1961, was produced by a flare surge occurring on the western limb of the sun at 1552 UT. The evolution of the various features—optical, radio, and geophysical—during a five-hour period are described and related to a series of sketches of the H$_\alpha$ filtergrams made at Ottawa, Canada. The large intensity of the impulsive microwave burst at 10.7 cm and the explosive character of the flare surge give the event special significance. (auth)

**5182** DIRECTIONAL FLUX DENSITIES AND MIRROR-POINT DISTRIBUTIONS OF TRAPPED PARTICLES FROM SATELLITE 1958$\epsilon$ MEASUREMENTS. C. A. Lundquist, R. J. Naumann, and A. H. Weber (National Aeronautics and Space Administration, Huntsville, Ala.). J. Geophys. Res., 67: 4125-33(Oct. 1962).

Satellite 1958$\epsilon$ (Explorer 4) contained a directional plastic scintillation counter, prepared by Van Allen and associates, mounted with its axis perpendicular to the long symmetry axis of the satellite. Count-rate data from this detector have been analyzed to yield directional flux densities (particles per centimeter$^2$ second steradian) of geomagnetically trapped charged particles as a function of the angle with the perpendicular to the magnetic field. The direction of the counter axis as a function of time is determined from the modulations of ground-received RF signal strengths and detector counting rates produced by the body motions of the satellite. The directional particle flux densities are calculated by computer solutions of the integral equation relating observed count rates and the particle flux densities. Mirror-point distributions of the charged particles along magnetic field lines extending from the satellite position to lower altitudes are obtained directly from the particle flux density calculations. The data are presented both in terms of geographic coordinates and the dynamical invariants. Arguments are presented indicating that the charged particles detected are mostly electrons, predominantly of energy 720 kev. The corresponding omnidirectional electron flux density is approximately $7.4 \times 10^3$/cm$^2$ sec kev for the satellite locations over Huntsville. This value is two to three orders of magnitude larger than flux densities calculated by the neutron albedo mechanism. (auth)

**5183** ELECTRONS IN THE EARTH'S OUTER RADIATION ZONE. W. G. V. Rosser, B. J. O'Brien, J. A. Van Allen, L. A. Frank, and C. D. Laughlin (Iowa State Univ., Iowa City). J. Geophys. Res., 67: 4533-42(Nov. 1962).

Preliminary results from Explorer 12 during August and September 1961 show that near the geomagnetic equatorial plane the omnidirectional intensity of 40-55 kev electrons is usually constant to a factor of 2 or 3 between radial distances of 25,000 and about 55,000 km; then it diminishes rapidly near the termination of the earth's magnetic field, which is generally at about 65,000 km. Typical midzone values for electrons between 40 and 55 kev are $10^6$ to $10^7$ electrons $(cm^2\ sec)^{-1}$. The intensity of 80- to 100-kev electrons shows a similar radial dependence and a similar absolute value, but diminishes toward zero at a lesser radial distance. Hence the outer fringe of the outer zone at about 10 earth radii has a much steeper electron spectrum than the inner portion. The general structure of the outer zone as measured with a 302 Geiger tube by the staff members of this laboratory and other laboratories during the past four years is confirmed but is now shown to correspond to electrons of energy greater than 1.6 Mev in intensities of $10^3$ to $10^5$ $(cm^2\ sec)^{-1}$ in the heart of the zone. Important spectral changes accompany geomagnetic storms. (auth)

**5184** OBSERVATIONS OF THE VAN ALLEN RADIATION REGIONS DURING AUGUST AND SEPTEMBER 1959. 6. PROPERTIES OF THE OUTER REGION. R. A. Hoffman, R. L. Arnoldy, and J. R. Winckler (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 67: 4543-75(Nov. 1962).

The results of measurements with ion chamber and Geiger counter instruments aboard the Explorer 6 satellite are discussed in terms of the general intensity, structure, and shape of the outer radiation region as displayed by contours of constant counting rate from the Anton Geiger counter. These contour plots show the large variation in counting rate, volume, and structure to which the outer radiation region is subjected during magnetic activity. Frequently two maximums are observed in the outer zone. It is shown that the depth of the minimum between these maximums as a function of altitude is an argument against any earth surface magnetic anomaly as the cause of the minimum in intensity. An explanation given previously is again suggested, namely, that the minimum is a result of changing spectrum of the trapped electrons, together with the spectral response of the counting instruments. By using the Geiger counter rate along a magnetic line of force, together with the ionization rate ratio, to determine the constancy of the spectrum, pitch-angle distributions at the equatorial plane are derived. The equatorial pitch-angle distribution is unfolded by means of a form of Able's integral equation with a mathematical approximation to the counting rates as a function of magnetic field strength. The pitch-angle distribution is derived before and after a large magnetic storm. Finally, a discussion of properties of the outer radiation zone during magnetically quiet times and the changes associated with a series of magnetic storms during August and September are discussed in detail. It is concluded that major intensity changes always correlate with solar activity, a time delay indicating the coupling by means of solar plasma beams. Intensity changes are independent of the occurrence of a Forbush type decrease caused by the plasma cloud. Counting rate changes during storms mainly associated with energetic electrons near 1 Mev are observed. Counting rates near the equator decrease for all lines of force if the storm has a main phase. Sometimes the decrease near the equator is accompanied by an increase near the atmosphere showing the lowering of mirror points. The percentage decreases are larger for lines of force at large radial distances. Large decreases on all lines of force are accompanied by widespread aurora. Counting rate increases occur during the recovery phase of magnetic storms and are apparently due to a local acceleration mechanism. The increased flux consists of particles having large pitch angles with a spectrum similar to that of the prestorm conditions. (auth)

**5185** GAMMA RAYS IN SPACE, RANGER 3. James R. Arnold (Univ. of California, San Diego, La Jolla), Albert E. Metzger, Ernest C. Anderson, and Marvin A. Van Dilla. J. Geophys. Res., 67: 4878-80(Nov. 1962).

The moon probe Ranger 3 carried as one of its scientific packages an instrument designed to measure the interplanetary $\gamma$-ray flux. Data for more than 40 hours of operation are given and some conclusions which can be drawn concerning $\gamma$-ray astronomy are presented. The instrument consisted of a detector, a 32-channel pulse height analyzer, and a high-voltage power supply. (W.D.M.)

**5186** DISCUSSION OF PAPER BY PIZZELLA, MCILWAIN, AND VAN ALLEN, 'TIME VARIATIONS OF INTENSITY IN THE EARTH'S INNER RADIATION ZONE, OCTOBER 1959 THROUGH DECEMBER 1960.' W. N. Hess (National Aeronautics and Space Administration, Greenbelt, Md.). J. Geophys. Res., 67: 4886-7(Nov. 1962).

In a recent paper time variations in the earth's inner radiation zone were discussed. The count rate of the 302 G-M tube on Explorer 7 was analyzed, and conclusions were reached about time variations. It is pointed out in the present note that a completely different set of conclusions can be reached on the basis of the same experimental data. (W.D.M.)

**5187** DENSITY OF THE SOLAR FLARE PLASMA. E. L. Fireman (Smithsonian Astrophysical Observatory, Cambridge, Mass.). J. Geophys. Res., 67: 4890-1(Nov. 1962).

Energetic particles are imbedded in solar material ejected at low energy and commonly called the solar flare plasma. The density of this plasma is highly uncertain. The density of the plasma is estimated from the interaction of the solar cosmic rays with the plasma. These estimates do not require a knowledge of the distribution of the flare plasma along a line of sight. (W.D.M.)

**5188** ON THE EXISTENCE OF A PHASE ANTICIPATION IN TRAINS OF DIURNAL OSCILLATIONS OF COSMIC RAYS. M. Galli and P. Randi (Università, Bologna). Nuovo cimento (10), 26: 407-14(Oct. 16, 1962). (In English)

From a previous study of the association of diurnal oscillations and Forbush decreases of cosmic rays, an hypothesis was put forward that the Forbush decreases were complementary to diurnal oscillations. Inspecting the hourly statistics from meson scintillation monitors, it is concluded that many times the diurnal oscillations anticipate their phases by one day. (W.D.M.)

**5189** THE ABUNDANCE OF TRITONS AND DEUTERONS IN PRIMARY COSMIC RADIATION. M. V. K. Appa Rao and P. J. Lavakare (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 26: 740-7(Nov. 16, 1962). (In English). (NYO-10231)

An attempt has been made to determine the abundance of low-energy tritons and deuterons in a nuclear emulsion stack exposed at a geomagnetic latitude $\lambda = 61°$ N on August 3, 1958, under 3.8 $g/cm^2$ of matter. The grain density versus range method has been used for identification of the tracks produced by the singly charged nuclei. The selection criteria allow the observation of deuterons of kinetic energy (92 to 175) Mev per nucleon and tritons of (73 to 165) Mev per nucleon. The upper limits for the differential fluxes for tritons and deuterons are $3.5 \times 10^{-3}$ and $9.2 \times 10^{-3}$ meters per Mev for the energy ranges given above. The upper limit for the triton to $\alpha$-particle ratio for the same rigidity is 0.09. Some of the implications of these results are discussed. However, due to the uncertainty of the correction for secondary production within the atmosphere, the results are consistent with the absence of these elements in primary cosmic radiation. (auth)

**5190** COSMIC RAY THRESHOLD RIGIDITIES AND THE EARTH'S MAGNETIC FIELD. J. J. Quenby and G. J. Wenk (Imperial Coll. of Science and Tech., London). Phil. Mag. (8), 7: 1457-85(Sept. 1962).

Approximate corrections to the vertical threshold rigidities for cosmic rays in the earth's magnetic field are given, which take into account both the effects of the nondipole part of the internal field and the penumbra. The thresholds obtained are tabulated every 2½° geographic latitude and every 5° geographic longitude. The accuracy of these thresholds is discussed, and it is shown that they fit experimental data better than do previous approximations. (auth)

**5191** A LABORATORY SCALE MODEL FOR THE INVESTIGATION OF COSMIC RAY THRESHOLD RIGIDITIES. C. J. Bland (Imperial Coll. of Science and Tech., London). Phil. Mag. (8), 7: 1487-1501(Sept. 1962).

A technique is described for the study of the geomagnetic threshold rigidities by means of a laboratory-scale model in which the motion of the cosmic particles in the earth's magnetic field is simulated by that of a beam of electrons moving in the magnetic field of a terrella, scaled so as to represent the geomagnetic field. Störmer and main cone threshold rigidities have been detected by this technique both for the dipole representation of the geomagnetic field and for a field including nondipole terms roughly similar, in magnitude, to those occurring in the earth's field. The modifications to the Störmer threshold rigidities, calculated by the Quenby–Webber method for the terrella field, have been checked and a preliminary investigation of the effect on the threshold rigidities of uniform external fields has been carried out. (auth)

**5192** SPATIAL DISTRIBUTION OF COSMIC RAY INTENSITY AND GEOMAGNETIC THEORY. M. A. Pomerantz and S. P. Agarwal (Franklin Inst., Swarthmore, Penna.). Phil. Mag. (8), 7: 1503-11(Sept. 1962).

Data recorded in a world-wide investigation of relationships between the spatial distribution of cosmic-ray intensity and the magnetic field of the earth have been compared with the predictions of geomagnetic theory. Measurements obtained with a neutron monitor in the U. S. Navy Hydrographic Office Airborne Geomagnetic Survey-Project MAGNET are well organized in terms of new calculations of vertical threshold magnetic rigidities by Quenby and Wenk, who have taken into account the effects of the dipole and nondipole parts of the field as well as the penumbral correction. Except for the observations over one region in the North Atlantic, a plot of nucleonic intensity versus threshold rigidity reveals that all the points fall within a narrow band. (auth)

**5193** STUDY OF THE HYDROGEN, HELIUM, AND HEAVY NUCLEI IN THE NOVEMBER 12, 1960 SOLAR COSMIC-RAY EVENT. S. Biswas, C. E. Fichtel, and D. E. Guss (National Aeronautics and Space Administration, Greenbelt, Md.). Phys. Rev., 128: 2756-71(Dec. 15, 1962).

A study of the composition and energy spectra of solar cosmic rays from the Nov. 12, 1960, solar flare has been made using rocket-borne nuclear emulsions. The abundances of hydrogen, helium, carbon, nitrogen, oxygen, neon, and larger nuclei have been determined, and upper limits were set for light nuclei ($3 \leq Z \leq 5$) and fluorine nuclei. The relative numbers of helium, light, medium ($6 \leq Z \leq 9$), and large ($Z \geq 10$) nuclei in the solar beam were found to be 680 ± 110, <0.1, 10, and 1.0 ± 0.3, respectively. The composition was seen to be similar to that of the solar atmosphere as determined by spectroscopic means, for those elements where a comparison could be made, but markedly different from that of galactic cosmic rays. The differential energy per nucleon spectra of hydrogen, helium, and medium nuclei could be represented by an equation of the form $dJ/dW = K(W/W_0)^{-\gamma}$ for kinetic energies greater than 35 Mev per nucleon. The values of $\gamma$ for He nuclei and medium nuclei were the same within uncertainties, but were larger than that for hydrogen nuclei by a factor of more than two in the energy interval from 40 to 130 Mev/nucleon. In spite of the different energy/nucleon spectra, the ratio of protons to heavier nuclei in the same energy/nucleon interval was the same at different times in the event and also the same as that observed in two other events. The measurements are shown to be consistent with a diffusion process which has a predominantly velocity dependent diffusion coefficient at low energies, as suggested by Parker, and therefore the different energy/nucleon spectra mentioned earlier are most probably due to differences generated by the acceleration process. Present ideas concerning the acceleration mechanism for solar cosmic rays are discussed in relation to the experimental results. (auth)

**5194** RADIATION STUDIES IN SPACE WITH NUCLEAR EMULSION DETECTORS. Herman Yagoda (Air Force Cambridge Research Labs., Bedford, Mass.). Space Sci. Rev., 1: 224-77(Oct. 1962). (In English)

Recent techniques of transatmospheric exposure of nuclear emulsions are reviewed in which the instrument section is returned by parachute, the low impact velocity permitting the exposure to be conducted in the presence of a minimum of surrounding condensed matter. Exposures from Aerobee-Hi, Nike-Cajun, Thor-Able, Atlas, and Viking rockets and from Discoverer satellites are discussed. (W.D.M.)

**5195** ENERGETIC PARTICLES IN THE INNER VAN ALLEN BELT. Wilmot N. Hess (Goddard Space Flight Center, Greenbelt, Md.). Space Sci. Rev., 1: 278-312(Oct. 1962). (In English)

A survey is given of the high energy particle populations in the inner radiation belt. The experiments which have given information about particles are discussed and the best experimental information about particle fluxes and spectra presented. Calculations are given which deal with the particles and indicate what particle sources and loss processes are most important. The role of neutrons in making the inner belt is considered in detail and the need for particle acceleration and/or other sources is shown. (auth)

**5196** DIRECTION OF THE COSMIC RAY ANISOTROPY. Arne Eld Sandstroem, Eric Dyring, and Stig Lindgren (Inst. of Physics, Uppsala). Tellus, 14: 19-32 (1962).

Inclined meson telescopes at Uppsala, Kiruna, and Murchison Bay were employed to determine the direction of the C.R. diurnal anisotropy. The six mean asymptotic directions are distributed between approximately 15° N and 80° N. It is shown that the flow of excess particles responsible for the anisotropy is parallel to the orbital plane of the earth. All atmospheric effects were considered as well as the partial smoothing out of the diurnal variation through the longitudinal distribution of the asymptotic directions. Inside the limits of error the yearly mean amplitudes fit a linear function of the cosine of the angle between the equatorial plane and the mean asymptotic direction. The direction of the anisotropy makes an angle of approximately 90° with the earth-sun line, the flow of excess particles overtaking the earth. (auth)

**5197** YIELD AND ANGULAR DISTRIBUTION OF ČERENKOV RADIATION FROM EXTENSIVE AIR SHOW-

ERS. Technical Note No. 5. Henry Kasha (Israel Inst. of Tech., Haifa), Yona Oren, and Kurt Sitte. Preprint No. AFCRL-62-1046. Prepublication Copy. 12p.

The relative yield and angular distribution of Čerenkov radiation from extensive air showers (EAS) were measured as a function of the shower size in the range $4 \times 10^4$ to $2 \times 10^6$ particles. It was found that the larger showers were not as efficient in producing Čerenkov radiation as the smaller ones. The effect could be understood in light of the results on the angular distribution of Čerenkov radiation near the shower axis which was found to be peaked more forward in larger showers. This result also led to the conclusion that the angular distribution of electrons with energy >21 Mev near the axis of EAS was dependent on the shower size. (auth)

## Criticality Studies

**5198** (HASL-124) EFFECTIVE MULTIPLICATION FACTORS FOR BARE CYLINDERS. Stephen J. Lanes (New York Operations Office. Health and Safety Lab., AEC). May 1962. 25p.

A computer program is presented for a two-group calculation of the effective multiplication factor in cylindrical containers. Included is a series of graphs relating this factor to container dimensions and the concentration of $U^{235}$ in the container. Since the range of dimensions and concentrations investigated covered both subcritical and supercritical systems, the information presented is of use to the designer as well as the reviewer of storage and transportation methods. (auth)

## Elementary Particles and Radiations

**5199** (AERE-R-3969) CHARGED π-MESON PRODUCTION IN PROTON-PROTON COLLISIONS AT 1 Gev KINETIC ENERGY. W. Galbraith, G. Manning, A. G. Parham, (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England); M. A. R. Kemp, (Gt. Brit. National Inst. for Research in Nuclear Science, Harwell, Berks, England); and E. J. Sacharidis (Birmingham. Univ., England). July 1962. 16p.

The energy spectrum of charged π mesons emitted in p-p collisions at 1.02 Bev kinetic energy was studied using a differential gas Cherenkov counter to measure the velocity of the mesons. The energy spectrum at 15 to 25° to the forward direction in the laboratory fits more closely the spectrum shape predicted by the isobar model of meson production than that predicted by the statistical model (no isobar formation), and there is evidence for a forward-backward peaking in the emission of the isobar in the CM system of the colliding nucleons. The results are discussed in the light of other recent work on the production of π mesons in p-p collisions at 2 and 3 Bev kinetic energy. (auth)

**5200** (IS-299) POSITRON ANNIHILATION IN SOLIDS. A. R. Mackintosh (Ames Lab., Ames, Iowa). Oct. 1962. Contract W-7405-eng-82. 34p.

An experimental study of the angular correlation of the photons from the annihilation of positrons with electrons in solids is discussed, with particular reference to the information about the electronic structure which can be derived from the results. Approximate calculations were made of the angular distribution of coincidences for an interacting electron gas, a superconductor, a collective-electron ferromagnet and a liquid metal, and the results were compared with experiment. A number of experiments designed to explore the electronic structure of solids are suggested, and possible improvements in experimental technique are proposed. (auth)

**5201** (JINR-P-1051) O PERENORMIROVKE AKSIAL'NOI KONSTANTY β-RASPADO. On the Renormalization of β Decay Axial Constant). Van-hieu Nguyen (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 6p.

The renormalization of the beta-decay axial constant in the Chew-Low theory with a fixed nucleon is considered. The renormalization constant $\lambda = -(G_A/G_V)$ is expressed in terms of the renormalized pion-nucleon interaction constant and of the total cross sections for pion-nucleon scattering. (auth)

**5202** (TID-14840) A STUDY OF THE $K^+$ DECAY. A. M. Boyarski, E. C. Loh, L. Q. Niemela, D. M. Ritson (Massachusetts Inst. of Tech., Cambridge. Lab for Nuclear Science); R. Weinstein (Northeastern Univ., Boston); and S. Ozaki (Brookhaven National Lab., Ill.). Feb. 5, 1962. Contract AT(30-1)-2098. 18p.

Some properties of the various decay modes of $K^+$ mesons were studied with Hodoscoped scintillation counters. One hundred and twenty-two $K\mu_3$ events were identified in the high energy end of the muon energy spectrum from 115 ± 3 to 134 Mev which yielded (0.42 ± 0.10)% as the relative branching ratio. The result, together with the $Ke_3$ branching ratio and the low energy end of the $K\mu_3$ muon energy spectrum, was found to satisfy a constant form factor V-A interaction. A lifetime analysis on this sample gave $\tau K\mu_3 = (1.06 \pm 0.16) \times 10^{-8}$ second, which is in agreement with the present K lifetime of $(1.224 \pm 0.013) \times 10^{-8}$. The longitudinal polarization of the $K\mu_3$ events was found to be $0.8 \pm {}^{.2}_{.3}$. The relative $K\mu_2/K\pi_2$ ratio was determined to be 2.98 ± 0.25, which is 3 S.D. away from the emulsion result $R = 2.3 \pm 0.17$. However, it is in agreement with the more recent Xenon chamber result $R = 3.46 \pm 0.07$ published by Roe, et al. A search for the occurrence of an intermediate mass lepton in the decay $K \rightarrow \chi + \nu$ established $3 \times 10^{-4}$ as the upper limit for the branching ratio for $m_e < m_\chi < 75$ Mev. (auth)

**5203** (UCRL-6499) THE MICROSCOPIC BASIS OF MACROSCOPIC ELECTROSTATIC AND MAGNETOSTATIC ENERGY. Allan N. Kaufman (California. Univ., Livermore. Lawrence Radiation Lab.) and Toshio Soda (California. Univ., Berkeley). June 27, 1961. Contract W-7405-eng-48. 35p.

A microscopic description of the electromagnetic interactions among a set of charged particles, valid to terms of order $c^{-2}$, was used to derive a number of expressions for macroscopic electrostatic and magnetostatic "energy" and "work." Particular attention was paid to the assumptions required for the validity of these expressions, and to the relations between the various nonequivalent expressions bearing the same name (such as "magnetic work"). (auth)

**5204** (UCRL-6558-T) UNIQUENESS AND REARRANGEMENT COLLISIONS. B. A. Lippmann (California. Univ., Livermore. Lawrence Radiation Lab.). July 21, 1961. Contract [W-7405-eng-48]. 7p.

The integral equation for rearrangement collisions was examined in the light of the remark that it is not always appropriate to proceed to the limit $\epsilon \rightarrow 0$. A boundary condition was derived that shows the integral equation to have unique solutions, and the analog of the Born approximation is discussed. (auth)

**5205** (UCRL-6559-T) INELASTIC SCATTERING AND THE BOLTZMANN EQUATION. J. R. Terrall (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 1962. Contract W-7405-eng-48. 80p.

The restrictions imposed by energy-momentum conservation on the scattering integrals in the Boltzmann equation were derived for both photons and matter particles. The assumption was made that the binding energies, motions, and position correlations of the scatterers in the medium are negligible. The angle integrations in the scattering integrals were performed analytically with the result that integrals over the energy before scattering were left. From the relativistic equations for the general two-product collision process, the relations which apply in the elastic and inelastic scattering of photons and matter particles were derived as special cases. It was found that, in the case of nonrelativistic particles, the inelastic contribution to the particle flux at a given energy E comes from an energy range before scattering which is broader than the range from which elastic contributions come by the factor $[1 + (1 - m/M)E_{ex}/E]^{1/2}$ . ($E_{ex}$ is the excitation energy of the scatterer in its residual state, while m and M are the rest energies of the scattered particle and scatterer, respectively.) For photons this factor is $[1 + (1 + E_{ex}/2M)E_{ex}/E]$. On the other hand, though these factors may be large at low energies, there is a kinematical factor in the scattering probability function which works in favor of elastic scattering. Certain integrals of the scattering probability functions were evaluated as a further means of comparing inelastic and elastic scattering from a given target. (auth)

**5206** (WAPD-T-1305) TRANSFORMATIONS BETWEEN HALF-RANGE AND FULL-RANGE ANGULAR EXPANSIONS AND THE TRANSPORT PROBLEM. Bruce D. O'Reilly (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Mar. 1961. Contract AT(11-1)-GEN-14. 21p.

Transformations were derived which relate the expansion coefficients of an arbitrary function $f(\omega)$ represented in terms of a complete set of functions orthogonal over (−1, +1), and its expansion coefficients in a representation in terms of the members of a pair of such sets orthogonal over (−1,0) and (0,+1). The expansion sets were then specialized to full-range and half-range polynomials, and the results used to obtain a general expression for the angularly reduced scattering integral in the double-P representation of the one-dimensional transport equation. The reduction of the scattering integral is illustrated for the cases of scattering without deflection and isotropic scattering. General formulas for obtaining representations of the transformation matrices are given. (auth)

**5207** PARABOLIC LAW FOR ELECTROMAGNETIC WAVE MAXIMUM ABSORPTION BY IONIZED GASES. V. P. Mihu (Univ. of Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 259-63(1962). (In Rumanian)

The parabolic law, known for the case of hydrogen and expressed by the equation $P - P' = a\sqrt{I_m}$, was used by T. B. Ionesku for determining that the ratio $K(K + 1) = C\sqrt{I_m}$ (where C is a constant) exists between ionized current intensity, corresponding to the hydrogen maximum absorption energy, and the proper quantum rotation number K. It is shown that the equation for hydrogen also holds for oxygen. Thus, the parabolic law should also hold for ionized oxygen under d-c discharge. (tr-auth)

**5208** OBSERVABLES OF RELATIVISTIC PARTICLES. L. M. Garrido and J. Sesma (Facultad de Ciencias, Zaragoza, Spain). Am. J. Phys., 30: 887-90(Dec. 1962).

The most general unitary transformation that transforms the Hamiltonians of particles of spins 0, ½, or 1, into Hamiltonians containing even or odd matrices only, is studied. The expressions for the position operators for each transformation that are valid for the three kinds of particles are presented. (auth)

**5209** ON THE STRUCTURE OF ELEMENTARY PARTICLES. T. Tati (Universidade, São Paulo, Brazil and Univ. of Kanazawa, Japan). Anais Acad. Brasil. Cien., 34: 325-36(Sept. 30, 1962). (In English)

The structure of elementary particles is discussed in terms of the generalization of the fundamental theory, compound models of elementary particles, and the conserving quantities and primary interactions. (W.D.M.)

**5210** ON THE COUPLING CONSTANT IN A MODEL WITH UNSTABLE PARTICLE. Z. Bialynicka-Birula (Inst. of Physics, Academy of Sciences, Warsaw). Bull. acad. polon. sci., Sér. sci., math., astron. et phys., 10: 305-8 (1962). (In English)

The scattering amplitude and complex N-Θ (nucleon-meson) coupling constant are investigated for a fixed-fermion field theory having one unstable fermion. (T.F.H.)

**5211** ON A RENORMALIZABLE THEORY OF VECTOR MESONS. I. Białynicki-Birula (Univ. of Warsaw). Bull. acad. polon. sci., Sér. sci., math., astron. et phys., 10: 309-10(1962). (In English)

The free-meson propagator at high momenta is considered from the viewpoint of the functional formalism. The generating functional of the Green's functions for the vector meson field is found to be convergent, if integration over all fields is replaced by integration over all fields obeying the Lorentz condition. Interactions of vector meson fields with other fields are discussed. (T.F.H.)

**5212** SOME CONSIDERATIONS OF THE THERMODYNAMICS OF THE ISOLATED PARTICLE. Louis de Broglie. Compt. Rend., 255: 1052-4(Aug. 6, 1962). (In French)

Some applications of the thermodynamics of the isolated particle recently described (Compt. rend., 255: 807(1962)) are given. They concern the relationship of the Hamilton principle with the second principle of thermodynamics and with the study of the fluctuation of the self-mass. (tr-auth)

**5213** EQUATION DESCRIBING PARTICLES WITH TWO MASS STATES. V. Fuchs (Faculty of Mathematics and Physics, Prague) and I. Úlehla. Czech. J. Phys., 12: 573-87(1962). (In English)

The paper deals with the basic properties of the simplest equations, corresponding to representation of the Lorentz group with maximum spin 3/2. It gives the representations of matrices which appear in these equations, the subsidiary conditions and solutions in the forceless case. The consistency of the equations after the introduction of electromagnetic interaction is proved and the magnetic moments of the particles are calculated. The equations describing particles with two mass states are dealt with in greater detail. The distinguishability of the two mass states is investigated and the lifetimes of the excited mass states at electromagnetic interaction are calculated. (auth)

**5214** CONTRIBUTION TO THE INTERACTIONS OF FAST PIONS WITH ATOMIC NUCLEI. J. Patočka and J. Tuček (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 12: 647-8(1962). (In English)

The angular and impulse distribution of the relativistic paths of particles emitted in the reaction of 4.5 Bev $\pi^-$ with nuclei are studied. The measurements of the impulses were performed on 89 secondary relativistic paths. From the dependence of the mean angle of dispersion on the ionization it was found that in 7 cases protons were emitted in directions mostly containing low angles with the path of the primary pion. (W.D.M.)

**5215** ELEMENTARY PARTICLES. S. C. Horning. Nature, 196: 158(Oct. 13, 1962).

An attempt is made to indicate relations between the properties of elementary particles and the natural constants when dimensional units are defined in a particular way. (L.T.W.)

**5216** A "POTENTIAL" FOR LOW ENERGY $\alpha$–N INTERACTION. A. N. Mitra, V. A. Bhasin, and B. S. Bhakar (Univ. of Delhi). Nucl. Phys., 38: 316-21(Oct. 1962). (In English)

A separable potential model of alpha-nucleon interaction is proposed on lines similar to an approach to p-p scattering. Only s- and p-wave interactions are considered. The parameters reproduce the s- and p-phase shifts up to about 20 Mev. Both s- and p-wave interactions are attractive and, as expected, the spin-orbit potential is much smaller than the central potential. The attractive s-wave interaction predicts a bound $He^5$ state as a 2-body system. (auth)

**5217** PROPERTIES OF THE ELASTIC SCATTERING AMPLITUDE AT HIGH ENERGIES. V. N. Gribov (Inst. of Physics and Tech., Leningrad) and I. Ya. Pomeranchuk. Nucl. Phys., 38: 516-28(Nov. 1962). (In English)

It is shown that the imaginary part of the scattering amplitude $A_1(t,s)$ is positive and has all positive derivatives with respect to the momentum transfer t in the nonphysical region up to its first singularity given by the Landau curve $t = t_1(s)$. Hence for the Regge pole with largest l, $dl/dt > 0$ in this interval. The dependence of l on t is studied when $t \to 4\mu^2$. It is proved that l(t) goes into the upper half-plane when $t > 4\mu^2$. All results are obtained without the assumption of the existence of a Hamiltonian. Different possibilities are discussed for the dependence l(t) when $t \to \infty$. It is analyzed whether the poles corresponding to the "elementary particles" are continuous functions of l. It is shown that in calculating the spectral density $\rho(s,t)$ the condition $s(t - 4\mu^2) < \mu^4$ is the condition of neglecting all singularities in the l plane except the pole with with the maximum Re l. (auth)

**5218** ON THE REDUCTION OF FIELD OPERATOR ALGEBRA IN THE CASE OF VACUUM DISINTEGRATION. H. Reeh and S. Schlieder (Max-Planck-Institut für Physik und Astrophysik, Munich). Nuovo cimento (10), 26: 32-42 (Oct. 1, 1962). (In German)

It is pointed out that from theorems of Borchers and Ruelle it follows: a relativistic quantum field theory fulfilling the axioms of Wightman, having $p_\mu = 0$ as an isolated value in the momentum spectrum, and being cyclically represented with a vacuum state as a cyclic vector is irreducible, if and only if it has just one vacuum state. A proof of Borchers' theorem, that an irreducible quantum field theory has only one vacuum state, and the reduction of the algebra $\mathscr{A}$ of field operators for the case of several vacuum states (the subspace $\mathscr{H}_\Omega$ of Lorentz invariant states may have infinite dimension) are given. The case of spinor fields and special cases of indefinite metric are considered. (auth)

**5219** SOME CONSEQUENCES OF CONSERVED AND PARTIALLY CONSERVED CURRENTS. Fr. G. Lannoy and J. Nuyts (Faculté des Sciences, Orsay, France). Nuovo cimento (10), 26: 107-17(Oct. 1, 1962). (In English)

Using the partially-conserved current ideas, a unified version of leptonic decays is obtained which could explain the violation of the $\Delta S = \Delta Q$ rule, decay rates of K-mesons and baryons, and branching ratios. This excludes a two-spurion scheme. (auth)

**5220** MASS-DIFFERENCE AND STRANGENESS EFFECTS IN HYPERON-NUCLEON SCATTERING. P. A. Protopapadakis (Imperial Coll. of Science and Tech., London). Nuovo cimento (10), 26: 134-9(Oct. 1, 1962). (In English)

The formal features of a partial wave dispersion theoretical treatment of hyperon-nucleon scattering are discussed, from the standpoint of their differences with respect to nucleon-nucleon scattering. (auth)

**5221** THE ANNIHILATIONS $\bar{N}N \to \bar{K}K$ AND $\bar{Y}Y$. N. J. Sopkovich (Carnegie Inst. of Tech., Pittsburgh). Nuovo cimento (10), 26: 186-9(Oct. 1, 1962). (In English)

Some results of calculations made for the processes $\bar{N}N \to \bar{K}K$ and $\bar{N}N \to \bar{Y}Y$ are presented and compared with experiment. The possibility of an absorptive effect explaining the discrepancy between experiment and theory for the annihilations is considered. (W.D.M.)

**5222** PION PRODUCTION AT THRESHOLD WITH STRIP APPROXIMATION. M. Cassandro (Università, Rome). Nuovo cimento (10), 26: 196-9(Oct. 1, 1962). (In English)

It has been shown that for spinless particles the strip approximation and the peripheral method are equivalent for the calculation of total cross sections. This result is extended to physical properties in the case of $\pi$-N scattering, introducing spin and isospin. It then becomes possible to test the reliability of a peripheral approximation with introducing phenomenological considerations. The cross section for the reaction $\pi^- + p \to \pi^+ + \pi^- + n$ is calculated in the strip approximation. (W.D.M.)

**5223** SOME REMARKS ON THE $\lambda_{13}$ DECAY. L. Egardt (University Coll., London). Nuovo cimento (10), 26: 200-1(Oct. 1, 1962). (In English)

During the past few years the V-A theory has had considerable success in describing weak interactions not involving strange particles and recent experiments on $K_{13}$ decays have shown that strange particles can be included into the theory. Some implications of various theoretical assumptions on the proton-electron angular correlation and the proton spectrum in leptonic $\Lambda$ decay are briefly discussed. (W.D.M.)

**5224** ON THE HIGHER SYMMETRIES OF STRONG INTERACTIONS. P. Breitenlohner (Universität, Graz, Ger.). Nuovo cimento (10), 26: 231-46(Oct. 16, 1962). (In German)

Some of the proposed higher symmetries of strong interaction are investigated, and it is shown that the $SU_3$-symmetry in the form of Gell-Mann and Ne'eman (8-fold way) fits best the known baryons and mesons. For this symmetry the 346 meson-baryon scattering amplitudes are reduced to 7 invariant amplitudes. Furthermore the invariant three-point-function is investigated, and the form of the Hamiltonian of meson-baryon-interaction is derived. Finally the attempt is made to associate a representation of $SU_3$ to the baryon-isobars. (auth)

**5225** AN INTEGRAL EQUATION FOR HIGH-ENERGY CROSS-SECTIONS. C. Ceolin (Università, Padua), F. Duimio, R. Stroffolini, and S. Fubini. Nuovo cimento (10), 26: 247-60(Oct. 16, 1962). (In English)

The properties of an integral equation for high energy cross sections derived in the framework of the multiperipheral model are studied. Asymptotic expressions in the form of a power law are derived, the exponent depending on the solution of a one-dimensional homogeneous Fredholm equation. The structure of this eigenvalue equation is discussed together with its analogy with the two-body Bethe-Salpeter equation. (auth)

**5226** ANOMALOUS PROPERTIES OF THE VECTOR FIELDS IN INTERACTION WITH DIRAC'S CURRENT. B. Jouvet (Collège de France, Paris). Nuovo cimento (10), 26: 283-97(Oct. 16, 1962). (In English)

The properties of the solutions of the equations of a vector field (of arbitrary mass) in interaction with Dirac's current, fulfilling successively the postulates of covariance, causality, and canonical quantization, were studied. It was found that such solutions may have various forms, all of which violate the postulates either of unitarity, or of vacuum as a minimal energy state, but not necessarily for observable states. The solutions contain contributions, unexpected from the spectral postulate, associated to states $|h_0(p)>$ of zero mass and zero spin and unobservable. If the observable states have a positive norm: (a) the norms of the states $|h_0(p)>$ are negative; (b) the commutation relations are only compatible if the renormalization constant $Z_1$ is zero; (c) the unrenormalized polarization tensor should have the gauge-invariant form $[\delta_{\mu\nu} - (p_\mu p_\nu)/(p^2 - i\epsilon)]F(p^2)$, $F(0) \neq 0$, which is quite different from the usual perturbation expression. If one omits the contributions of the states $|h_0(p)>$, the equation which determines their norm becomes the new definition for the bare mass of the vector boson, and ghosts should appear in observable states. (auth)

**5227** ANALYTIC PROPERTIES OF THE SCATTERING AMPLITUDE OF TWO INTERACTIVE CHARGED PARTICLES IN A YUKAWA TYPE POTENTIAL. H. Cornille (Laboratoire Joliot-Curie de Physique Nucléaire, Orsay, France) and A. Martin. Nuovo cimento (10), 26: 298-327(Oct. 16, 1962). (In French)

A rigorous derivation is presented of the analytic properties of the S-wave scattering amplitude when, in addition to a superposition of Yukawa potentials, a Coulomb interaction is present. The method of proof starts from the usual effective range function which as well known is free of Coulomb singularities. It is shown that this effective range function is analytic in a strip in the k complex plane. Then, making use of the analytic properties of superpositions of exponential potentials with respect to the distance r we can solve the Schrödinger equation along a ray in the r-plane and rotate the initial strip of analyticity in k. Eventually we find that the effective range function is meromorphic in the whole k plane except for two cuts. As in the noncoulombic case the S-matrix can be written as the ratio of two functions, one with the lower cut, another one with the upper cut. The zeros of the denominator of S in the upper half k-plane can still be interpreted as bound states located on the imaginary k-axis. The connection between the successive Born approximations and the discontinuity of S in the upper half-plane is rigorously established and, from the integral representation of S we easily obtain the integral equation connecting the discontinuity in the upper half-plane and S itself. Finally the asymptotic behavior of S is studied. (auth)

**5228** A DISPERSIVE FORMULATION OF THE LEVINSON THEOREM. B. Bosco (Inst. for Advanced Study, Princeton, N. J.). Nuovo cimento (10), 26: 342-50 (Oct. 16, 1962). (In English)

The statement of the Levinson theorem on the relation between the scattering phase-shifts and the number of bound states is transferred in a dispersive language through a relation involving the unphysical discontinuity of the scattering amplitude, the residue of the bound state, and the binding energy. It is shown that the relation obtained are necessary and sufficient condition for the validity of the Levinson theorem. An example to illustrate this relation is given. (auth)

**5229** THE INHOMOGENEOUS LORENTZ GROUP AND THE CONFORMAL GROUP. W. A. Hepner (Imperial Coll. of Science and Tech., London). Nuovo cimento (10), 26: 351-68(Oct. 16, 1962). (In English)

An isomorphism exists between the group of Dirac's four-row $\gamma$-matrices and the continuous conformal group, the well-known combinations $(1 \pm \gamma_5)\gamma_i$ being the generators of translations and acceleration while $\gamma_5$ generates dilatations. Destroying the unphysical higher symmetries, a representation of the inhomogeneous Lorentz group is derived with the following new features: (i) The translation operators have intrinsic parts, viz. the combinations $(1 + \gamma_5)\gamma_i$; (ii) Consequently there are additional restrictions on the four-field interaction, the only possible combination being $a_s(\bar{\psi}_A \psi_B)(\bar{\psi}_C \psi_D) + a_v(\bar{\psi}_A (1 + \gamma_5)\gamma_i \psi_B)(\bar{\psi}_C (1 + \gamma_5)\gamma_i \psi_D)$. If one of the four fields transforms like an ordinary Dirac spinor, or if $\psi_A$ and $\psi_D$ transform in this way, while the other fields belong to the representation with intrinsic translations, then the constant $a_s$ must vanish, and the interaction is of the type suggested by Feynman and Gell-Mann. (auth)

**5230** SELF-COUPLED MESON FIELD: EQUATIONS FOR SINGLE PROPAGATORS, THEIR SOLUTION FOR A NUMERICAL MODEL, CONSIDERATIONS ON THE CONVERGENCE OF PERTURBATIVE EXPANSIONS. E. R. Caianello and A. Compolattaro (Università, Naples and Istituto Nazionale di Fisica Nucleare, Naples). Nuovo cimento (10), 26: 390-400(Oct. 16, 1962). (In English)

It is shown that all the independent equations, or conditions, that can be derived for a single propagation kernel from all the branching equations that connect it and its derivatives with respect to the parameters of the theory with kernels of arbitrarily high order reduce to a small and unique set. It is then shown that whereas the only information one can get from the majoration of a regularized perturbative expansion of the kernels is that all majorants are divergent, a numerical model obtained by imposing that the free propagators in configuration space depend only upon the mass can be exactly solved if these equations are used. One finds that the general solution is a linear combination of hypergeometric functions of the coupling constant $\lambda$ which is singular for $\lambda = 0$; there is, however, a unique choice of constants which yields a solution regular when $\lambda = 0$. This model is related to the asymptotic form of the correct theory if the latter is defined over an infinitesimal space-time volume; this feature renders the results obtained useful in the explicit study of the renormalization group of the theory. (auth)

**5231** AN INVESTIGATION OF JETS BASED ON THE FIREBALL MODEL. K. Imaeda (Dublin Inst. for Advanced Studies). Nuovo cimento (10), 26: 418-39(Nov. 1, 1962). (In English)

An analysis was made of 227 jets of energy between $10^{10}$ ev and several $10^{14}$ ev collected from several laboratories. Based on the fireball model, calculation was made of the angular distribution of the secondary particles of the jet in the laboratory system and the dispersion $\sigma$, anisotropy D, and inelasticity K for each individual jet. It is confirmed that K varies as $1/\gamma_c$, and the fireball model is compatible with the experimental results in the energy region of $E_p = 10^{12}$ ev to $10^{14}$ ev. The experimental value of K, however, gives too large a value for $E_p < 10^{12}$ ev and too small a value in the energy region of $E_p > 10^{14}$ ev. Also, the value of D is a little smaller than expected from the fireball model. Based on the experimental result, a process is suggested that, besides the emission and disintegration of fireballs, the contribution of the mesons from the disintegration of the excited nucleon, and the direct production of secondary particles due to core-core interaction, plays an important role for the multiple meson production in high-energy interaction. (auth)

**5232** THE RESCATTERING CORRECTION TO THE DEUTERON ELECTRODISINTEGRATION. B. Bosco and R. B. De Bar (Stanford Univ., Calif.). Nuovo cimento (10), 26: 604-12(Nov. 1, 1962). (In English)

An evaluation of the S-wave rescattering correction for the deuteron electrodisintegration cross section is discussed on the basis of a treatment previously proposed by one of the authors. It is shown that this correction is quite important for the determination of the neutron form factors. Experiments permitting the extension of the present treatment to the P-waves are suggested. (auth)

**5233** ON THE TENFOLD WAY. S. L. Grashow and J. J. Sakurai (Univ. of Copenhagen). Nuovo cimento (10), 26: 622-4(Nov. 1, 1962). (In English)

The authors in a recent paper (Nuovo cimento, 25: 337 (1962)) predicted the existence of a $Y = -1$ (strangeness = $-2$) $T = \frac{1}{2}$ baryon with a mass of 1520 Mev and a $Y = -2$ (strangeness = $-3$) $T = 0$ baryon with a mass of 1640 Mev, both particles having a spin $J = \frac{3}{2}^+$. Subsequently, the existence of a $\pi\Xi$ resonance with $T = \frac{1}{2}$ and mass 1530 Mev was experimentally established. The authors add several comments to their earlier paper. In particular, a correction in the mass formula gives revised mass values for the $Y = -1$ and $Y = -2$ states of 1532 Mev and 1679 Mev, respectively. The hyperon is called $Z^-$, and its properties are conjectured. (L.T.W.)

**5234** AN EMPIRICAL REGULARITY OF THE WEAK INTERACTIONS. F. Chilton (Univ. of Washington, Seattle). Nuovo cimento (10), 26: 628-32(Nov. 1, 1962). (In English)

Data on the weak two-body decay modes of elementary particles are examined, and a regularity in the decay is noted. The possibility of this regularity being fundamental is investigated. (L.T.W.)

**5235** GAUGE INVARIANCE AND THE STRUCTURE OF CHARGED PARTICLES. L. Motz (Columbia Univ., New York). Nuovo Cimento (10), 26: 672-97(Nov. 16, 1962). (In English)

The Weyl principle of gauge invariance is used to obtain an enlarged gauge-invariant curvature tensor consisting of the usual Einstein-Ricci tensor plus terms involving the electromagnetic potentials and field strengths. An invariant Lagrangian density is constructed by multiplying this tensor by a metric tensor consisting of a symmetric and an anti-symmetric part. By introducing an arbitrary transformation of gauge into this Lagrangian density, an operator is obtained which has exactly the form required by the second-order Dirac theory, and the variational principle then gives the second-order Dirac equation provided the position occupied by the particle is interpreted as being a localized noneuclidean region in which the Gaussian curvature is equal to the reciprocal of the square of the Compton wavelength. One of the consequences of this interpretation is that the Newtonian constant of gravitation inside a particle must be enormously larger than it is in empty space and must depend on the mass of the particle. To obtain self-consistent results, one has to assume this constant to be of the order of $\hbar c/m^2$, that is, the reciprocal of the fine structure constant multiplied by the square of the specific charge of the particle. This assumption leads to a very interesting model of a charged particle in which the electrostatic repulsive forces are held in equilibrium by the large interior gravitational forces. Mass renormalization terms of the right form and order of magnitude as well as a mechanism to account for the capture of photons by charged particles are also obtained. The cosmological consequences of this theory are discussed. (auth)

**5236** PROTON-PROTON COLLISIONS AT 19.8 Gev/c. F. F. Abraham and R. M. Kalbach (Univ. of Arizona, Tucson). Nuovo Cimento (10), 26: 717-39(Nov. 16, 1962). (In English)

Elastic and inelastic 19.8 Bev/c proton-proton collisions in nuclear emulsions are examined using an external proton beam of the CERN Proton Synchrotron. Multiple scattering, blob density, range, and angle measurements give the momentum spectra and angular distributions of secondary protons and pions. The partial cross sections corresponding to inelastic interactions having two, four, six, eight, ten, and twelve charged secondaries are found to be, respectively, (16.3 ± 8.4) mb, (11.5 ± 6.0) mb, (4.3 ± 2.5) mb, (1.9 ± 1.3) mb, (0.5 ± 0.5) mb, and (0.5 ± 0.5) mb. The elastic cross section is estimated to be (4.3 ± 2.5) mb. The mean charged meson multiplicity for inelastic events is 3.7 ± 0.5, and the average degree of inelasticity is 0.35 ± 0.09. Strong forward and backward peaking is observed in the center-of-mass system for both secondary charged pions and protons. Distributions of energy, momentum, and transverse momentum for identified charged secondaries are presented and compared with the results of work at other energies and with the results of a statistical theory of proton-proton collisions. (auth)

**5237** DISPERSION THEORY OF THE DEUTERON FORM FACTOR AND ELASTIC e-d SCATTERING. H. F. Jones (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 26: 790-802(Nov. 16, 1962). (In English)

The anomalous threshold discontinuities of the deuteron form factors are calculated by an extension of Cutkosky's method to the spinor case. The form factors are then evaluated in a tail approximation and substituted into the single photon exchange term for elastic e-d scattering. The resulting expression is very similar to the Jankus formula, but shows that the usual modification $e \rightarrow eF_1^s$ should more correctly be $e \rightarrow eF_{ch}^s(1 - s/4m_d^2)^{-1}$. The bare form factors should also be multiplied by $(1 - s/4m_d^2)^{-1}$. Small-angle scattering is re-analyzed with the new formula; the changes are largely masked by the experimental uncertainties, but result in a small increase in the neutron form factor $F_1^n$. (auth)

**5238** FORMAL SIMILARITIES OF WEAK, STRONG AND ELECTROMAGNETIC INTERACTIONS. M. Baker and S. L. Glashow (Stanford Univ., Calif.). Nuovo Cimento (10), 26: 803-12(Nov. 16, 1962). (In English)

It is shown that symmetries of strong interactions, weak interactions, and electrodynamic interactions can be isomorphic, although conflicting. The simplest group of elementary particle transformations admitting this possibility is SU(3). It is also shown that the weak interactions may be invariant under a weak-parity operation, an admissible representation of space reflection which is not a symmetry of the strong interactions. (auth)

**5239** AN ANALYSIS OF ELECTRON-PROTON SCATTERING. J. S. Levinger (Cornell Univ., Ithaca, N. Y.). Nuovo Cimento (10), 26: 813-20(Nov. 16, 1962). (In English)

The measurements of electron-proton differential scattering cross sections have been fitted successfully using a dispersion-theoretic form. One fit uses the $\rho$, $\omega$, and $\eta$ resonances, and small hard cores. Seventy-one experimental points give a $\chi^2$ value of 178. A second fit uses the $\rho$ and $\omega$ resonances, and also a soft core at about 1100 Mev, and a small hard core. The 71 experimental points give a $\chi^2$ value of 209. (auth)

**5240** MACROSCOPIC MOTION OF CLASSICAL SPINNING PARTICLES. P. Nyborg (Univ. of Oslo). Nuovo Cimento (10), 26: 821-30(Nov. 16, 1962). (In English)

Equations common to various authors are deduced from general principles. It is shown how different subsidiary conditions affect the particle motion. The various earlier theories that allow an inner motion lead to unrealistic macroscopic motion of the particle. The general principles leading to the equations of motion are modified to give a macroscopic motion corresponding to real particles. (auth)

**5241** DIFFUSION OF ELECTRONS IN A SCATTERING MEDIUM. E. Blue, J. H. Ingold, and W. J. Ozeroff (General Electric Co., Pleasanton, Calif.). Phys. Fluids, 5: 1576-9 (Dec. 1962).

The diffusion approximation to the more exact transport theory of charged-particle flow in a scattering gas is described and used to calculate the potential and electron-density distributions for a simple case. In this simple case, electrons are emitted from a plane source and flow to a plane collector through the scattering gas under the influence of a density gradient and of electric fields produced by a combination of space-charge fields and externally applied fields. The resultant current-voltage relationship is complicated; however, a plot of ln J vs ln $V_a$, where J is the electric current density and $V_a$ the applied voltage, has a slope which varies from one to two, according to whether the major component of the electric current is the density gradient or the electric field respectively. (auth)

**5242** ELECTRIC POLARIZABILITY OF THE DEUTERON. C. F. Clement (Atomic Energy Research Establishment, Harwell, Berks, Eng. and Princeton Univ., N. J.). Phys. Rev., 128: 2724-8(Dec. 15, 1962). (PUC-1962-79)

The polarizability of the deuteron is calculated for several assumed deuteron wave functions, and the values obtained are compared with previous results. The best value is $0.63 \times 10^{-39}$ cm³. The method used gives an approximate wave function of the deuteron in the nuclear electric field. The approximations of the method are examined and are found to be best for low-energy deuterons incident on relatively light nuclei. (auth)

**5243** NUCLEON-NUCLEON DIFFRACTION SCATTERING. Ugo Amaldi, Jr. (CERN, Geneva) and Franco Selleri. Phys. Rev., 128: 2772-83(Dec. 15, 1962).

A calculation of diffraction effects in nucleon-nucleon collisions is carried out by using the unitarity of the S matrix. In the diffraction approximation, a set of coupled integral equations for the Wolfenstein amplitudes is derived. The inhomogeneous terms are calculated by taking into account the intermediate state with one pion and two nucleons. For the inelastic matrix elements the modified one-pion-exchange expressions have been used. The integral equations are then solved by a numerical iterative procedure; the results are compared with experiments around 1 Bev. The shape of the experimental cross section is reproduced, but evidence is obtained that potential scattering is still important at these energies. A remarkable prediction is the appearance of a backward peak in neutron-proton scattering. (auth)

**5244** DECAY MODE $\omega \rightarrow 2\pi + \gamma$. Paul Singer (Northwestern Univ., Evanston, Ill.). Phys. Rev., 128: 2789-92 (Dec. 15, 1962).

The width of the decay mode $\omega \rightarrow 2\pi + \gamma$ is calculated, assuming that it proceeds through a $(\rho\pi)$ intermediate state. The $\gamma$ energy spectrum, which happens to be strongly asymmetric, is also presented. The ratio $(\omega \rightarrow 2\pi + \gamma)/(\omega \rightarrow 3\pi)$ is evaluated by using two different theoretical models and it is concluded that the $2\pi^0 + \gamma$ mode is appreciably less frequent than the $\pi^0 + \gamma$ mode. Finally, the experimental implications are discussed. (auth)

**5245** METHOD TO MEASURE THE LIFETIME OF THE $\Sigma^0$ HYPERON. Kerson Huang (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 128: 2793-2807(Dec. 15, 1962). (TID-15822)

A method, suggested by Wattenberg, to measure the lifetime of the $\Sigma^0$ hyperon is analyzed theoretically. The suggested method consists of measuring the distribution of angles between the Dalitz pairs emitted in the process $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$, in which the $\Sigma^0$ was previously produced in a nucleus. The distribution function contains a part that depends both on the charge Z of the nucleus and on the lifetime of $\Sigma^0$. This part comes from the interference between the Z-dependent part of the matrix element with the Z-independent part. This interference owes its existence to two facts: that the target nucleon is in a bound state, and that the $\Sigma^0$ has a finite mass width. The effects of nuclear structure can be eliminated from the problem. A family of curves for the distribution functions corresponding to various values of the lifetime is obtained through the use of Born approximation for the Coulomb wave functions of the Dalitz pair. If the lifetime is in the neighborhood of $5 \times 10^{-20}$ sec, then measurements with an accuracy of 10% would determine the lifetime to within a factor of 10. (auth)

**5246** VECTOR MESONS AND THE KN, $\overline{K}$N INTERACTIONS. R. C. Arnold and J. J. Sakurai (Univ. of Chicago). Phys. Rev., 128: 2808-9(Dec. 15, 1962). (EFINS-62-33)

The effect of the exchanges of $\rho$ and $\omega$ on the KN and $\overline{K}$N scattering amplitudes is examined with special attention to the question of whether the $\rho$ and $\omega$ exchanges can provide a dynamical mechanism for binding an s-wave $\overline{K}$N system in the T = 0 state. (auth)

**5247** $\Lambda$-NUCLEON SCATTERING AND THE PION-HYPERON COUPLING CONSTANTS. J. J. de Swart and C. K. Iddings (Univ. of Chicago). Phys. Rev., 128: 2810-24(Dec 15, 1962). (EFINS-62-36)

Using the prescription laid down by Brueckner and Watson, the pion contribution to the hyperon-nucleon potentials for both even and odd $\Sigma$ parity was calculated. The coupled Schrödinger equations are solved numerically taking into account the $\Lambda\Sigma$ mass difference. Fitting the $\Lambda$-nucleon scattering lengths, as obtained from the hyperfragment data, the coupling constants were determined. When the same core ($x_c = 0.35\ \mu^{-1}$) is used in all channels and $f_{NN}{}^2 = 0.08125$, $f_{\Lambda\Sigma}{}^2 = f_{\Sigma\Sigma}{}^2 = 0.0841$ for the even $\Sigma$-parity case and $f_{\Sigma\Sigma}{}^2 = 0.0225$ ($f_{\Sigma\Sigma} < 0$) and $g_{\Lambda\Sigma}{}^2 = 0.578$ for the odd $\Sigma$-parity case. The rationalized pseudovector coupling constant is denoted by f and the rationalized scalar coupling constant by g. For these coupling constants and cores, the cross sections for $\Lambda$-nucleon scattering below $\Sigma$ threshold were calculated. The results suggest the presence of attractive spin-orbit potentials. (auth)

**5248** INTERPRETATION OF $\rho$ AND $\zeta$ MESONS. Yukihisa Nogami (National Research Council, Ottawa). Phys. Rev., 128: 2825-7(Dec. 15, 1962).

The $\rho$ and $\zeta$ mesons are assumed to have the same quantum numbers, $I = J = 1$. The P-wave pion-pion scattering is then studied in the hope that the two resonances, $\rho$ and $\zeta$, can be ascribed to the existence of one unstable vector meson B of iscspin one. Besides the process $2\pi \rightleftharpoons B$, a strong attractive interaction between pions in the $I = J = 1$ state, which is caused by the exchange of B between pions and also by baryon loops, etc., is considered. The pion-pion scattering amplitude is calculated by the chain-diagram approximation and two resonances, which can be identified with the $\rho$ and $\zeta$ mesons, are obtained. The two resonances in the kaon-pion system are discussed on the same lines. (auth)

**5249** MAGNETIC MOMENT OF A LEE PARTICLE. David L. Fried and L. Sartori (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 128: 2879-87(Dec. 15, 1962).

A version of the Lee model is constructed, in which the particles are charged and the interaction resembles that of pseudoscalar meson theory. The allowed processes are $V \rightleftharpoons N + \theta$, $\theta \rightleftharpoons X + \overline{X}$, where V, N, and X are all fermions which are formally treated as distinct. Relativistic energy-momentum relations are used for all the particles. In this model the eigenstate of the physical V particle is determined, and its magnetic moment is calculated. Some problems concerning the mass and charge renormalizations are discussed. A cutoff is employed in order to avoid the difficulties with the state normalizations which are characteristic of the Lee model. If the renormalized coupling constant G is small enough, all the components of the physical eigenstate have positive amplitudes. For somewhat larger values of G, the expressions for the moments are still well defined, even though parts of the eigenstate have negative amplitudes. Some modifications of the model are considered. The analog of the meson-nucleon static model gives moments which differ by a factor of about 2 from the exact results. (auth)

**5250** M MESON AND A GENERALIZATION OF THE POMERANCHUK RELATIONS. William G. Wagner and David H. Sharp (California Inst. of Tech., Pasadena). Phys. Rev., 128: 2899-2905(Dec. 15, 1962).

Under the hypothesis that a K-$\pi$ resonance is vector, its role in the associated production of $\Lambda$ by $\pi$ and in $\Lambda$ production by $\overline{K}$ is examined. The existence of a new symmetry between two reaction amplitudes is demonstrated. This symmetry may be regarded as a generalization of Pomeranchuk's relations and should appear at high energies and low momentum transfers when both amplitudes are dominated by the same pole or pseudopole, as is to be expected according to the Regge pole hypothesis. Specifically, in considering the details of the role of a strange vector meson in the processes $\pi + N \to \Lambda + K$ and $\overline{K} + N \to \Lambda + \pi$, it is found that the associated production amplitude in the forward direction (for the K) at high energies is asymptotically equal to the negative of the amplitude characterizing $\Lambda$ production by a $\overline{K}$. The contribution of the dominant pole terms in these amplitudes is constructed for the high-energy limit and the energy and momentum transfer dependences are compared for the alternative hypothesis of composite or elementary particle behavior of a pole term. Experiments are discussed which are needed to supply data for a test of the Regge pole hypothesis. The results of these experiments, which are feasible with the new large accelerators, will be most important as guides for the construction of theories of the strong interactions. (auth)

**5251** DEPARTURES FROM ONE-PION EXCHANGE IN 1.25-Bev $\pi^-$-p INTERACTIONS. E. Pickup, D. K. Robinson, and E. O. Salant (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 9: 170-3(Aug. 15, 1962).

The production of $\rho^0$ by 1.25 Bev pions in the reaction, $\pi^- + p \to \pi^- + \pi^+ + n$, was studied as a test of One-Pion Exchange (OPE). It is shown that other mechanisms are important in the production, even for low momentum transfers. There are indications that $\rho^0$ is distorted by the $\omega$ resonance. On the OPE diagram considered, an angle $\alpha$ is defined by the angle between the plane of the momenta of the virtual pion and the target proton and the plane of the momenta of the virtual and scattered pions. The $\pi$-$\pi$ scattering angle is $\theta$. The effects of $\alpha$ on the number of events and on $\theta$ are presented. The asymmetry parameter for events of different $\pi$-$\pi$ mass, M+-, and $\pi^+$-$\pi^-$ effective mass curves are plotted and discussed. (H.D.R.)

**5252** STUDY OF PION-PION INTERACTIONS FROM PION PRODUCTION BY PIONS. Leonard B. Auerbach, Tom Elioff, William B. Johnson, Joseph Lach, Clyde E. Wiegand, and Thomas Ypsilantis (Univ. of California, Berkeley). Phys. Rev. Letters, 9: 173-6(Aug. 15, 1962). (UCRL-10212 and Rev.)

Reactions $\pi^\pm + p \to \pi^\pm + \pi^+ + n$ were studied at an incident pion momentum of 1.75 Bev/c. The experimental apparatus and procedure are described in detail, and the measured and calculated data are presented and discussed. Evidence was found of a pion-pion interaction in the ($\pi^+$-$\pi^-$) system, although the extrapolation method of analysis appeared to fail. No comparable resonance state was found for the ($\pi^+$-$\pi^+$) system. Processes other than the one-pion exchange are indicated even at relatively low momentum transfers. (H.D.R.)

**5253** EVIDENCE FOR VECTOR-MESON EFFECTS ON $\pi^0$ PHOTOPRODUCTION FROM HYDROGEN. R. M. Talman, C. R. Clinesmith, R. Gomez, and A. V. Tollestrup (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 9: 177-80(Aug. 15, 1962).

Angular distributions from the reaction $\gamma + p \to p + \pi^0$ were measured in an attempt to isolate the contribution of the virtual exchange of one neutral vector meson. The experimental apparatus and procedure are described, and measured and calculated data are presented. It is found that above the third pion-nucleon resonance such a pole process becomes important. Two hypotheses are advanced as to which vector mesons are contributing, and the data are discussed in respect to these hypotheses. The relevant coupling constants are calculated from the data, and their accuracy is discussed. (H.D.R.)

**5254** POSSIBLE RESONANCES IN THE $\Xi$ $\pi$ AND $K\overline{K}$ SYSTEM. L. Bertanza (Brookhaven National Lab., Upton, N. Y.), V. Brisson, P. L. Connolly, et al. Phys. Rev. Letters, 9: 180-3(Aug. 15, 1962).

The existence of marked departures from phase space in the effective-mass distributions for $\Xi$-$\pi$ and K-$\overline{K}$ states is described. Data are given for $K^-$ interactions with protons at incident energies of 2.24 and 2.5 Bev/c. The evidence indicates that, in about 25% of the events observed, the $\Xi$-$\pi$ state results from the decay of a resonant state ($\Xi^*$) with a mass of 1535 Mev and a full width <35 Mev. An observed anomaly in the K-$\overline{K}$ effective-mass distribution is possibly open to different interpretations, but if it is assumed to be due to the decay of a resonant state $K^*$, $M_{K^*} = 1020$ Mev, it has a full width of 20 Mev. The effect also may possibly be explained as due to S-wave K-$\overline{K}$ scattering. These interpretations and preliminary evidence concerning the properties of the $\Xi^*$ and $K^*$ are discussed. (H.D.R.)

**5255** REGGE POLE MODEL FOR HIGH-ENERGY p-p AND $\bar{p}$-p SCATTERING. F. Hadjioannou, R. J. N. Phillips, and W. Rarita (CERN, Geneva). Phys. Rev. Letters, 9: 183-6(Aug. 15, 1962).

A realistic model is presented of p-p and $\bar{p}$-p scattering, using the vacuum Regge pole trajectory (P), a second vacuum trajectory related to the p-p total cross section (P′), and an $\omega$ trajectory to give the big difference in p-p and $\bar{p}$-p scattering. The data predictions from the model are compared to data from the one-pole model from 3 to 30 Bev/c. It is concluded that the three-pole model fits qualitatively the existing data on high-energy p-p and $\bar{p}$-p scattering in its range of validity, and that one-pole analyses need certain corrections but remain qualitatively valid. (H.D.R.)

**5256** THEORY OF NONLEPTONIC HYPERON DECAY. S. P. Rosen (Clarendon Lab., Oxford). Phys. Rev. Letters, 9: 186-9(Aug. 15, 1962).

A theory of nonleptonic hyperon decay is proposed in which the observed relations $\alpha_+ \approx \alpha_- \approx 0$, $\alpha_\Lambda \approx -\alpha_0$, and $\alpha_\Xi \approx -\alpha_\Lambda$ are derived from time-reversal invariance, the $\Delta T = 1/2$ rule, and three doublet symmetries. Using this theory, the weak electromagnetic decay rates for $\Xi^- \rightarrow \Sigma^- + \gamma$ and $\Sigma^+ \rightarrow p + \gamma$ are predicted to be equal, and their asymmetry parameters are opposite in sign. (H.D.R.)

**5257** LOW-MASS ANOMALY IN PHOTOPRODUCTION OF PION PAIRS. Burton Richter (Stanford Univ., Calif.). Phys. Rev. Letters, 9: 217-20(Sept. 1, 1962).

An investigation was made of a previously observed anomaly in the production of pion pairs, in the isotopic spin state T = 0 of the two pions, thought to be caused by a final-state interaction of the two pions or the production of some particle. An attempt was made to observe the anomaly (for convenience called ABC) in the reaction $\gamma + p \rightarrow p + ABC$, without any restriction on the possible decay modes of the ABC, if it is a particle. The experimental measurements yield ABC properties as: mass = 322 ± 8 Mev, width ≤20 Mev (full width at half maximum), and the center-of-mass differential cross section for single-particle production, $(d\sigma/d\Omega)\text{cm}, 90° = (0.75 \pm 0.20) \times 10^{-30}$ cm²/sr. (H.D.R.)

**5258** ELASTIC p-p CROSS SECTIONS AT HIGH-MOMENTUM TRANSFERS. W. F. Baker (Brookhaven National Lab., Upton, N. Y.), E. W. Jenkins, A. L. Read, G. Cocconi, V. T. Cocconi, and J. Orear. Phys. Rev. Letters, 9: 221-3(Sept. 1, 1962).

Experimental measurements were made on the p-p elastic cross section at a squared four-momentum transfer $-t = 6.15\ (\text{Bev}/c)^2$ as well as an upper limit on the same cross section at $-t = 11.1\ (\text{Bev}/c)^2$. The elastic events were selected by requiring the coincidence of both recoil and scattered protons. Measurements were taken at an internal beam momentum $p_0 = 11.2$ Bev/c with $-t = 6.15\ (\text{Bev}/c)^2$ and $p_0 = 16.0$ Bev/c and $-t = 11.1\ (\text{Bev}/c)^2$ and compared to similar measurements made at CERN. Using the results of both sets of measurements, the t dependence of the Regge term $\alpha(t)$ is derived and the accuracy of the experimental points is discussed. (H.D.R.)

**5259** PROPERTIES OF THE $\eta$ MESON. H. Foelsche, E. C. Fowler, H. L. Kraybill, J. R. Sanford, and D. Stonehill (Yale Univ., New Haven). Phys. Rev. Letters, 9: 223-6 (Sept. 1, 1962).

Results are presented from 102 charged eta meson decays produced in four-pronged reactions of a $\pi^+$ beam in the Brookhaven 20-inch hydrogen bubble chamber at incident energies of 1090 and 1260 Mev. At both energies, a large number of cases of the reactions $\pi^+ + p \rightarrow p + \pi^+ + \pi^+ + \pi^-$ and $\pi^+ + p \rightarrow p + \pi^+ + \pi^+ + \pi^- + \pi^0$ were observed. From reactions consistent with the production of an eta meson, several properties of the eta meson were indicated. The half-width of the eta is less than 5 Mev. Its mass is 548 ± 1 Mev and 551 ± 2 Mev from the 1090 and 1260 Mev data, respectfully. The results favor $0^{-+}$ for the spin, parity, and G-parity, and definitely exclude the simple isospin-conserving assignments $0^{--}$, $1^{+-}$, and $1^{--}$. A small amount of the decay mode $(\pi^+ \pi^- \gamma)$ was present in the data. (H.D.R.)

**5260** PHOTOPRODUCTION OF MUON PAIRS IN CARBON. A. Alberigi-Quaranta, M. De Pretis, G. Marini, A. Odian, G. Stoppini, and L. Tau (Laboratori Nazionali del Sincrotrone, Rome). Phys. Rev. Letters, 9: 226-9(Sept. 1, 1962).

A 1000-Mev synchrotron bremsstrahlung beam was used in the production of muon pairs from a carbon target. From events in which electromagnetic muons were detected, ratios of the absolute experimental cross sections to the theoretical were calculated for three momentum channels of the $\mu^+$ and for two angular channels of the $\mu^-$. Theoretical values were calculated from the Bethe-Heitler formula, and the average difference from the experimental values is only about 5%. (H.D.R.)

**5261** PROPERTIES OF THE $\Xi^-$ HYPERON. L. Bertanza (Brookhaven National Lab., Upton, N. Y.), V. Brisson, P. L. Connolly, et al. Phys. Rev. Letters, 9: 229-32 (Sept. 1, 1962).

Samples of cascades with and without visible Λ decay were chosen to determine some of the properties of the $\Xi^-$ hyperon. The cascade hyperons were produced in the reactions $K^- + p \rightarrow \Xi^- + K^+$, $K^- + p \rightarrow \Xi^- + K^+ + \pi^0$, and $K^- + p \rightarrow \Xi^- + K^0 + \pi^+$, where $\Xi^- \rightarrow \Lambda + \pi^-$. These samples were chosen from a large number of $K^-$-p interactions at 2.3 and 2.5 Bev/c $K^-$ beam energy. The $\Xi^-$ mean mass and lifetime are determined as 1321.0 ± 0.5 Mev and $(1.16^{+0.26}_{-0.17}) \times 10^{-10}$ seconds, respectfully. The data favor spin J = 1/2. Assuming J = 1/2 and that there are no appreciable strong interactions in the Λ-p final state, the cascade asymmetry parameter, experimental distribution, likelihood function $(L(\alpha\,\Xi))$, and time-reversal parameter are evaluated. The effect of final-state interactions is briefly discussed. (H.D.R.)

**5262** RECIPROCAL BOOTSTRAP RELATIONSHIP OF THE NUCLEON AND THE (3,3) RESONANCE. Geoffrey F. Chew (Univ. of California, Berkeley). Phys. Rev. Letters, 9: 233-5(Sept. 1, 1962). (UCRL-10272)

It has been proposed that within the framework of the analytically continued S-matrix all strongly interacting particles are composites, held together by forces associated with "crossed" channels. The essence of the Chew-Low theory for the (3,3) resonance is that in first approximation this particle is a pion-nucleon composite, held together primarily by exchange of a nucleon. A mechanism, called the reciprocal bootstrap, is outlined to show that in the same sense and with the same degree of experimental verification the nucleon is approximately a composite of a pion and a nucleon, bound together to a large extent by exchange of a (3,3) resonance. (H.D.R.)

**5263** ELECTROMAGNETIC RADIATIVE CORRECTIONS AND THE ELEMENTARY NATURE OF THE PHOTON. Maurice Lévy (Stanford Univ., Calif.). Phys. Rev. Letters, 9: 235-8(Sept. 1, 1962).

The electromagnetic radiative corrections in photon interactions at high energy are examined as to their association with Regge poles. Starting from the corrected elastic cross section for electron scattering by a potential, it is shown that the summation of a large number of emissions and absorptions of soft, or infrared, photons leads to a Regge behaviour of electron scattering cross sections which is directly connected with the energy spectrum of positronium. Conclusions based on the induced Regge behavior in the cross sections are presented and discussed. (H.D.R.)

**5264** REGGE POLES AND LANDAU SINGULARITIES. V. N. Gribov (Ioffe Inst. of Physics and Tech., Leningrad) and I. Ya. Pomeranchuk. Phys. Rev. Letters, 9: 238-42 (Sept. 1, 1962).

A scattering amplitude as a function of energy t and momentum transfer s has singularities at threshold values of these variables and on Landau curves. An examination was made of the accumulation of Landau curves near the threshold values of t and how this accumulation is manifested in the behavior of singularities of the amplitudes as functions of angular momentum l. It is shown that at $t = t_1$, corresponding to any two-particle threshold, the accumulation of an infinite number of poles on the line $\mathrm{Re}\ l = -\frac{1}{2}$ takes place. Arguments are also presented for the statement that at an energy corresponding to an n-particle production threshold, the accumulation of an infinite number of poles must occur on the line $\mathrm{Re}\ l = -\frac{1}{2} - \frac{3}{2}(n-2)$. (H.D.R.)

**5265** ON THE PROPERTIES OF THE MATRIX $\beta_5$ RELATIVE TO THE THEORY OF PARTICLES OF SPIN 1. J. Beckers (Université, Liège). Physica, 28: 1019-22(Oct. 1962). (In English)

It is shown that the matrix $\beta_5$ for spin 1 particles can be expressed in terms of the three matrices $\alpha_i$ occurring in the hamiltonian form of the theory, just as in the case of the matrix $\gamma_5$ for spin $\frac{1}{2}$ particles. (auth)

**5266** A REMARK ON THE INCLUSION OF LEPTONS IN ISOSPACE. D. Horn (Israel Inst. of Tech., Haifa) and Y. Ne'eman. Physica, 28: 1023-4(Oct. 1962). (In English)

**5267** ON THE CLASSICAL APPROXIMATION INVOLVED IN THE THOMAS-FERMI THEORY. M. J. Stephen and K. Zalewski (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 270: 435-42(Nov. 27, 1962).

The nature of the expansion of the particle density of a system in powers of $\hbar$ is investigated. An exact expression for the density in a system with an harmonic potential is obtained. There are two types of terms. First, there are steady terms which agree with those derived by other authors and yield in first approximation the Thomas-Fermi result. Secondly, there are oscillatory terms analogous to the de Haas-van Alphen terms in the susceptibility of an electron gas and which cannot be expanded in powers of $\hbar$. For systems with an odd number of dimensions the series of steady terms is shown to be divergent for all values of $\hbar \neq 0$. If the number of dimensions is even there is only a finite number of steady terms. (auth)

**5268** INVESTIGATIONS ON THE SECOND AND THIRD RESONANCES IN TERMS OF COMPOUND STATES. Hirofumi Hayashi (Nagoya Univ., Japan), Hisaichiro Okonogi, Shoichiro Otsuki, and Yoshio Sumi. Progr. Theoret. Phys. (Kyoto), 28: 215-32(Aug. 1962). (In English)

The second and third resonances in pion-nucleon scattering are investigated to see whether the resonance shape can be explained by a new isobaric field (called a compound particle field). Fairly good agreement with experiments has been obtained. To understand the compound particles, we make some speculations by making use of the full symmetry theory for the fundamental baryons of the Sakata model (the I-O-O theory). Difficulties with respect to the spin assignment of the compound particles by the I-O-O theory are investigated, and a possibility is discussed that the compound particles are bound states of two I-O-O particles. Some analogous features between the system of the Sakata model and the nucleus are also discussed. (auth)

**5269** ON AN EXTENSION OF THE MATHEMATICAL FRAMEWORK OF THE QUANTUM THEORY. II. MATHEMATICAL MEANING OF THE RENORMALIZATION THEORY. Hitoshi Wakita (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 28: 251-7(Aug. 1962). (In English)

Renormalizing the state vectors which represent the clouds of the proper fields of particles, we can define a new Hilbert space where the interaction Hamiltonian has a definite mathematical meaning. The success of the renormalization theory seems to show that the quantum theory of fields can be treated properly by using this new Hilbert space. Though this Hilbert space is not unique, states will be uniquely determined as linear functionals on some set of physical quantities. The clouds of the proper fields really exist, but they are not observed at all. (auth)

**5270** USE OF THE REQUIREMENT OF BARYON NUMBER CONSERVATION IN QUANTUM FIELD THEORY. Kunio Yamamoto (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 28: 258-64(Aug. 1962). (In English)

On the basis of the baryon number conservation or the fact that the pion is the lightest among the strongly interacting particles, the asymptotic behavior of some matrix elements for the space-like direction is discussed. A method of checking whether the given vertex function is consistent with this asymptotic behavior is proposed. It is shown that Jost's example has asymptotic behavior with small exponential decrease. (auth)

**5271** NUCLEON-NUCLEON SCATTERING IN MOMENTUM SPACE. Junko Goto (Rikkyo Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 28: 283-98(Aug. 1962). (In English)

The integral equations for nucleon-nucleon scattering in momentum space are solved numerically. $^1S_0$, $^1D_2$, and $^3P_1$ phase shifts for the non-static one-pion-exchange potential with full recoil are calculated at 10, 100, 200, and 310 Mev incident energies. They are compared with Born phase shift at these energies. Discussions on the accuracy of approximation methods which are used to reduce the integral equations to the feasible algebraic equations are given. (auth)

**5272** THEORY OF LEPTONS. Seitaro Nakamura (Tokyo Univ.) and Shigeo Sato. Progr. Theoret. Phys. (Kyoto), 28: 323-37(Aug. 1962). (In English)

Leptons and baryons are considered two states of one particle (fermion), multiplets for leptons being assumed to follow the pattern of those for baryons, that is, two kinds of neutrinos are assumed, each constituting a neutral component of muon doublet and electron doublet, respectively. A Hamiltonian of the weak interactions between the fermions and the intermediary mesons is introduced which is symmetric in the four-dimensional "super-charge" $(\kappa - \lambda)$ space. This leads to the two selection rules, one is $\Delta\lambda_3 = 0$ which denotes the conservation laws for the baryon number and for the lepton number, and the other $\Delta\kappa_3 = 0$ which enables us to exclude the majority of neutral currents for leptons. Besides the symmetric interaction of the Yukawa type through the intermediary mesons, the six-body couplings $\pi\pi e\nu\nu\nu$, $\pi\pi\mu\nu\nu\nu$, $K\pi e\nu\nu\nu$, and $K\pi\mu\nu\nu\nu$ through the boson isobars are introduced which obey $\Delta\lambda_3 = 0$ and $\Delta\kappa_3 = 0$. The Langer effect of the $\beta$-ray spectrum and the charge asymmetry of the decay of the neutral kaons in the $K_{e3}$ mode are explained in terms of the competitive channels of the I. M. process and of the six-body couplings. The effects on the inverse $\beta$-decay and the inverse muon capture are also discussed. (auth)

**5273** REGGE TRAJECTORIES AND PROTON-ANTIPROTON INTERACTION. Shigeo Minami (Osaka City Univ.). Progr. Theoret. Phys. (Kyoto), 28: 347-50(Aug. 1962). (In English)

It is shown that the experimental results for $\bar{p}$-p annihilation at 1.61 Bev/c can be explained in terms of the effects of the H* which is regarded as a resonant state in N-$\bar{N}$ systems and belongs to a Regge Trajectory with the quantum numbers of I = 0, odd parity, and odd G-parity. (auth)

**5274** ELECTROMAGNETIC FORM FACTORS OF NUCLEON. Akira Kanazawa and Tetsurô Sakuma (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 28: 351-60(Aug. 1962). (In English)

Electromagnetic form factors of the nucleon are investigated by taking into account the recently confirmed 2$\pi$ and 3$\pi$ resonances $\zeta$, $\rho$, $\eta$ and $\omega$. The isovector parts of the form factors are analyzed by the dispersion technique, where the $\pi$-$\pi$ scattering amplitude introduced by Bowcock and others is generalized to describe the two resonances simultaneously. By fixing $r_{1n} = 0$ and $r_{1p} = r_{2p} = r_{2n}$, we obtain the alternative formulae for the nucelon form factors, which contain three adjustable parameters. The parameters are the common root mean square radius r, and the two Clementel-Villi coefficients $x_1^s$ and $x_2^s$ associated with the scalar parts of the form factors. The formulae fit the empirical data excellently with $r = 0.866 \times 10^{-13}$ cm and reasonable values of other parameters. In connection with the discussion of the resonant amplitude, the existence of the so-called negative resonance is briefly discussed. (auth)

**5275** ON HARA-TAKEBE'S TREATMENT OF THE LEPTON ENERGY SPECTRA IN $K_{e3}^{+}$-DECAY. Susumu Furuichi (Rikkyo Univ., Tokyo), Shoji Sawada, and Minoru Yonezawa. Progr. Theoret. Phys. (Kyoto), 28: 402-4 (Aug. 1962). (In English)

It has been concluded (Hara, O., Takebe, H., Progr. Theor. Phys. 27(1962), 444) that the electron energy spectrum from $K_{e3}^{+}$ would be informative for the problem of the structures of $K^+$ and $\pi^0$. The authors had previously shown that in the case of V-A type Fermi interaction, it was impossible to obtain the energy spectra. An attempt is made to clarify some points of Hara and Takebe's results. (W.D.M.)

**5276** POMERANCHUK PARTICLE AND d-MESON REACTIONS. Shigeo Minami (Osaka City Univ.). Progr. Theoret. Phys. (Kyoto), 28: 404-6(Aug. 1962). (In English)

The decay of the Pomeranchuk particle (x-particle) and $\alpha$-meson production in N-N or $\pi$-N collisions are considered. (W.D.M.)

**5277** KINEMATICS OF HIGH-ENERGY PARTICLES. K. G. Dedrick (Stanford Univ., Calif.). Revs. Modern Phys., 34: 429-42(July 1962).

A condensed account of previously published formulas describing the energy, momentum, and angle transformations is given. Jacobians of the Lorentz transformations are discussed. A classification system is developed for reactions based both on the properties of the Jacobians and on the law giving the transformation of angles between the center-of-mass and the laboratory frames of reference. The use of the classification scheme is discussed. (L.T.W.)

**5278** THE LOW-ENERGY SCATTERING OF ELECTRONS AND POSITRONS BY HYDROGEN ATOMS. P. G. Burke (Univ. of California, Berkeley) and Kenneth Smith. Revs. Modern Phys., 34: 458-502(July 1962).

The elastic and inelastic (excitation, pickup, or ionization) collisions of slow electrons or positrons with hydrogen atoms are reviewed. A survey of the experiments that have been reported is given, and the theoretical attempts to calculate the relevant cross sections within the framework of nonrelativistic wave mechanics are reviewed. (L.T.W.)

**5279** PION-PION INTERACTIONS IN $\pi^+$-p COLLISIONS. D. L. Stonehill and H. L. Kraybill (Yale Univ., New Haven). Revs. Modern Phys., 34: 503-7(July 1962).

The occurrence of $\pi$-$\pi$ interactions in $\pi^+$-p collisions at incident $\pi^+$ kinetic energies of 910, 1090, and 1260 Mev is reported. The classification of these events by energy and by reaction products is shown and discussed. The properties of the observed resonance, called the $\rho$ meson, are reported. (L.T.W.)

**5280** ERRATA AND NOTE: ELEMENTARY PARTICLES AND SYMMETRY PRINCIPLES. M. A. Melvin (Florida State Univ., Tallahassee). Revs. Modern Phys., 34: 582-4(July 1962).

Errors found in the original paper (Revs. Mod. Phys., 32: 477(1960)) are listed. Also, an erroneous remark about the mathematics is corrected. (L.T.W.)

**5281** ELECTRON INELASTIC SCATTERING IN THIN FILMS. N. G. Nakhodkin, A. A. Ostroukhov, and V. A. Romanovskii (Kiev State Univ.). Soviet Phys.-Solid State (English Transl.), 4: 1112-19(Dec. 1962).

The theory of inelastic scattering of fast electrons in the case of large-angle single scattering is developed on the basis of the generalized model of continuous losses. The angular and thickness dependence of the inelastic scattering coefficient and the energy spectrum of the inelastically backscattered electrons are established. Measurements of the inelastic coefficient are made as a function of the electron angle of incidence and the film thickness. From a comparison of the theoretical and experimental data it is concluded that the model correctly describes the mechanism of the scattering of electrons in thin films. (auth)

**5282** SOLUTION OF THE KINETIC EQUATION FOR IMPURITY SCATTERING OF ELECTRONS. I. Ya. Korenblit (Semiconductor Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 4: 1225-6(Dec. 1962).

The scattering of electrons by ionized impurities is studied for the case in which the surfaces of constant energy of the scattered electron are oblate ellipsoids. The anisotropy of the electron mobility is found to be greater for an oblate ellipsoid than for a prolate ellipsoid. The relaxation properties of the medium are also discussed. (T.F.H.)

**5283** AXIOMATIC THEORY OF THE ELEMENTARY PARTICLES SYMMETRY. Y. V. Novozhilov. Vestnik Leningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 5-19 (1962). (In Russian)

In order to describe properties of fields, the notion of transformation is introduced. This notion contains some information from quantum field axioms (quantum postulates, positive definiteness of energy, uniqueness of the vacuum state, and gauge invariance). It is proposed to consider transformation properties as fundamental, from which symmetry properties of elementary particles can be extracted. It is shown that isospin symmetry is a consequence of basic axioms. Some additional statements about symmetries are also derived. (auth)

**5284** EVAPORATION PECULIARITIES OF RARE EARTHS CHLORIDES IN THE KCl, $LnCl_3$ (La, Ce, Pr, Nd) SYSTEMS. G. I. Novikov and A. K. Baev. Vestnik Leningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 89-97(1962). (In Russian)

The KCl$-$$LnCl_3$ (Ln = La, Ce, Pr, Nd) systems were investigated experimentally. Both molecules of simple chlorides and those of double chlorides were shown to convert into vapor upon heating. From experimental data the calculation of the vapor composition was estimated and thermodynamic functions of the processes of dissociation of double chlorides in vapor phase were calculated approximately. (auth)

**5285** ANALYSIS OF ENERGY SPECTRA OF POLARIZED NEUTRONS WITH THE AID OF A MAGNETIC FIELD. G. M. Drabkin (Leningrad Inst. of Physics and Tech.). Zh. Eksperim. i Teor. Fiz., 43: 1107-8(Sept. 1962). (In Russian)

A method is suggested for the analysis of neutron energy spectra based on the interaction of the neutrons with a varying magnetic field, whose frequency is related to the neutron velocity in the following manner: $\omega = \pi v/a$, where "a" is equal to half the period. The probability for the neutron to flip its spin is related to the function possessed by the sharp resonance lines in a magnetic field whose strength H is equal to $\pi v/\gamma a$, where "$\gamma$" is the gyromagnetic ratio. Taking advantage of the polarization of the neutrons their velocities can be analyzed with the aid of the magnetic field. For neutrons with a wave length of four Angstroms the magnetic analyzer does not have to be greater than 55 cm in length. (TTT)

**5286** CONCERNING THE COULOMB EXCITATION OF Λ-PARTICLES. D. V. Volkov (Leningrad Inst. of Physics and Tech.). Zh. Eksperim. i Teor. Fiz., 43: 1112-13(Sept. 1962). (In Russian)

It is possible to use the Coulomb excitation mechanism to investigate the lifetime of the $\Sigma^0$-hyperon resulting from the reaction: $\Lambda + X \to \Sigma^0 + X$, where X is any given nucleus. The Coulomb excitation matrix element, to a good approximation, does not depend on the isotopic spin for an isotopic doublet. A formula was therefore derived for the Coulomb excitation cross section for the doublet $H^3$ and $He^3$. From this formula an upper limit can be determined for the $\Sigma^0$-hyperon lifetime. (TTT)

**5287** PRODUCTION OF $\pi^+$ PHOTOMESONS IN THE ANGULAR RANGE 25–36° AND IN THE ENERGY INTERVAL 152–162 Mev. M. I. Abamovich, E. G. Gorzhevskaya, and F. R. Yagudina (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 43: 1113-16(Sept. 1962). (In Russian)

The differential cross section for the photoproduction of $\pi^+$ mesons with a momentum transfer ($k\omega - kq \cos\theta$) close to the threshold value of 0.93 was investigated. The relative pion and photon momenta are "k" and "q" respectively, while "$\omega$" is the center-of-mass energy of the pion. A film of polyethylene, 200 microns thick, was used as the target while an emulsion served as the detector. The cross section was measured for photons ranging in energy from 153.4 to 160.8 Mev. For this energy range the differential cross section was found to vary from 0.32 to 0.39 $10^{-29}$ $cm^2$/sterad. The experimentally measured values were found to agree with those calculated from theory. (TTT)

**5288** THE PROCESS, CORRESPONDING TO THE INVERSE OF THE DECAY $\pi \to \mu + \nu$ IN THE COULOMB FIELD OF A NUCLEUS. Yu. P. Nikitin and E. P. Shabalin. Zh. Eksperim. i Teor. Fiz., 43: 1119-20(Sept. 1962). (In Russian)

Interactions of high energy neutrinos taking place in nuclear Coulomb fields of the type $\nu + Z \to \mu(e) + \pi + Z$ and $\nu + Z \to \mu(e) + K + Z$ were considered. The cross sections for these two processes were derived using the Weizsäcker-Williams method. A table presents these calculated cross sections for neutrinos ranging in energy from 1 to 50 Bev and interacting in lead and iron. It was found that the cross sections for both processes increase with energy, that they are greater for interactions occurring in lead than in iron, and that the cross section for the first process is consistently greater than that for the second process. (TTT)

**5289** SELECTION RULES FOR ANTIBARYON-NUCLEON ANNIHILATION. Paul Haynal Moravek. Thesis, Nashville, Vanderbilt Univ., 1962. 194p.

The method used to calculate the selection rules was the transformation properties of fields and one-particle states under parity, charge conjugation, and G conjugation were determined; two-particle initial and final eigenstates of the symmetry operators and conserved quantities were constructed and their quantum numbers determined; and from the quantum numbers, detailed selection rules were tabulated for strong interactions. The selection rules are given in tables which list processes that conserve total angular momentum and third component of isospin, baryon number, and isofermion number. For each process listed, selection rules state whether or not each of the following is conserved: parity, total isospin, charge conjugation, and G conjugation. Conclusions are drawn from the selection rules concerning possible experimental tests that might be performed. In particular, a number of examples of the following types of possible tests are given: tests to determine elementary particle properties such as spin and intrinsic parity; possible tests to determine if a generalized Pauli principle holds for nucleon-antinucleon systems; and possible tests of charge independence in processes involving $\omega$ and $\rho°$ mesons. The conclusions appear to justify the calculation of the selection rules. (Dissertation Abstr., 23: No. 4, 1962)

**5290** QUANTIZATION OF THE 2-COMPONENT FERMION THEORY. George Henry Mullen. Thesis, Syracuse, N. Y., Syracuse Univ., 1962. 80p.

A 2-component spin ($^1/_2$) field was quantized consistently using an action principle with a Lagrangian containing higher order derivatives of the field. To insure the positive definiteness of the expectation values of physical observables an indefinite metric must be introduced. The field is the sum of a field obeying the known Feynman-Gell-Mann equation plus a massless field obeying a linear equation. The theory leads nicely to a pseudo-vector meson theory whose Lagrangian is identical to the one obtained for the electromagnetic case. That is, $eA_\mu$ is simply replaced by $ig\phi_\mu$. The Lagrangian obtained showed a connection between the gauge invariance of the theory and the way the field transforms under the proper Lorentz group. In order to have a physically interpretable S-matrix theory with an indefinite metric, only transitions between states of the same metric parity were allowed and also the Lagrangian must be metric invariant. For the electrodynamical case to second order, the restrictions eliminate the massless field in the interaction Lagrangian which then becomes nothing more than Dirac Lagrangian written in terms of 2-component spinors. Hence the theory gave the same results as the usual case. The restrictions did not eliminate the massless field in the case of weak interactions. In fact it suggested the possibility of identifying the massless field with the neutrino field. Since the neutrino carries no charge it would account for its not contributing in the electrodynamical case. (Dissertation Abstr., 23: No. 4, 1962)

**5291** POSITIVE PION PRODUCTION BY POLARIZED BREMSSTRAHLUNG. Richard Edward Taylor. Thesis, Stanford, Calif., Stanford Univ., 1962. 119p.

By selecting bremsstrahlung produced by 600-Mev electrons in a very thin foil, at a very small angle to the original electron direction, a beam of polarized photons was obtained. The variation of polarization and intensity with mean angle of emission of the photons was found to be in qualitative agreement with the theoretical predictions. The polarized photon beam was used to produce positive $\pi$-mesons from hydrogen at 90° cm angle of meson emission at photon energies of 242, 296, 337, and 376 Mev. The ratio of meson production along and at right angles to the electric field vector of the producing photon was measured and compared with theoretical predictions. The results agree with the relativistic dispersion theory of Chew, Low, Goldberger, and Nambu. (Dissertation Abstr., 23: No. 4, 1962)

**5292** THE LIFETIMES OF LIGHT HYPERFRAGMENTS. Lloyd Ray Fortney. Thesis, Madison, Wisc., Univ. of Wisconsin, 1962. 42p.

Existing film, from an exposure of the Berkeley 30 inch propane bubble chamber to a separated beam of 1.17 Bev/c $K^-$ mesons, was scanned for hyperfragment decays in flight. Due to the poor spatial resolution of the bubble chamber, it was possible to uniquely identify only the two body, mesonic decays of ${}_{\Lambda}H^3$ and ${}_{\Lambda}H^4$. Based on a sample of 6 mesonic decays in flight, a lifetime estimate of $0.63^{+0.5}_{-0.2} \times 10^{-10}$ seconds is obtained for ${}_{\Lambda}H^3$. Based on a sample of 4 mesonic decays in flight, a lower limit of $1.3 \times 10^{-10}$ seconds is placed on the ${}_{\Lambda}H^4$ lifetime. The results are in disagreement with the theoretical estimates of the lifetimes. (Dissertation Abstr., 23: No. 4, 1962)

## Neutron Physics

*Refer also to abstract 4864.*

**5293** (BNL-5987) DETERMINATION OF DIFFUSION COOLING IN GRAPHITE BY MEASUREMENT OF THE AVERAGE NEUTRON VELOCITY. E. Starr and J. W. L. de Villiers (Brookhaven National Lab., Upton, N. Y.). Jan. 2, 1962. Contract [AT(30-2)-Gen-16]. 16p.

The diffusion-cooling coefficient in graphite was determined by measuring the change in the asymptotic average velocity with buckling by pulsed neutron methods. The times necessary to establish equilibrium spectra in graphite and heavy water were measured and are reported. (auth)

**5294** (BRL-Memo-1432) A COMPLETE SET OF FUNCTIONS FOR DESCRIBING THE ANGULAR DISTRIBUTION OF THE NEUTRON FLUX FROM A POINT SOURCE IN AIR. R. H. Peterson and J. A. Williams (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Sept. 1962. 52p.

Based on the properties of Jacobi polynomials, a set of functions $g_n^m(\cos\theta)\cos m\phi$ which is complete over a unit sphere was developed. They differ from the spherical harmonics $P_n^m(\cos\theta)\cos m\phi$ in that the zonal terms $g_n^0(\cos\theta)$ contain singularities of order $(1-\cos\theta)^{-1/2}$ at $\theta = 0^0$ and are finite elsewhere thus providing a rapidly converging series for the observed peakedness of the angular distributions of neutron fluxes from a point source in air. Tables of the function $g_n^m(\cos\theta)$ as well as its integral and its adjoint for $0 \leq m \leq n$ and $0 \leq n \leq 4$ are included. (auth)

**5295** (CEA-2156) AUTOMATISATION SUR ORDINATEUR DE LA METHODE DES AIRES PARTIELLES DANS L'ANALYSE DES RESONANCES INDUITES PAR LES NEUTRONS S. I. SANS TERME D'INTERFERENCE. (Automatization on Ordinators of the Partial Area Method for the Analysis of "s" Neutron Induced Resonances. I. Without Interference Terms). G. Bianchi and C. R. Corge (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1962. 107p. (SPNBE-7)

A report on numerical analysis of transmission resonances induced by "s" wave neutrons in time-of-flight experiments is presented. The analysis method used is the partial area one. The only case treated is the one in which the interference term can be neglected. Programs and subroutines which determine from experimental raw data the resonant transmission, the partial areas, and the resonance parameters are described. (auth)

**5296** (EANDC-22L) STUDY OF COLD NEUTRON SOURCES. PRESENT STATUS AND PROGRAMMES IN EUROPE. Report on a Meeting held in Mol, June 29, 1962. M. Nève de Mevergnies (Mol, Belgium. Centre d'Etude de l'Energie Nucléaire). Aug. 1962. 7p.

The present status of cold neutron facilities either in operation or under construction is discussed along with requirements and plans for further studies and possibilities of international co-operation in this area. (J.R.D.)

**5297** (HW-75147) QUASI-ELASTIC SCATTERING BY ROOM TEMPERATURE LIGHT WATER. D. A. Kottwitz, B. R. Leonard, Jr., and R. B. Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1962. Contract AT(45-1)-1350. 18p.

The energy width and integrated intensity of the quasi-elastic scattering peak of light water at 22°C were measured on the Hanford triple-axis crystal spectrometer at a number of scattering angles for neutrons of energy 0.10, 0.15, and 0.25 ev. The energy resolution was 7, 11, and 10%, respectively. Wave-vector transfers ranged from 1 to 7 $Å^{-1}$. The quasi-elastic peak was assumed to have a Lorentzian shape in correcting the observed peaks for resolution. When plotted versus the square of the wave-vector transfer, both the corrected line width and integrated intensity exhibit systematic differences correlated with the energy of the neutrons used. In general, the present widths are greater than those obtained with cold and thermal neutrons. Neither the simple classical model nor the Singwi-Sjölander model for self-diffusion in water gives completely satisfactory agreement with the present results. (auth)

**5298** (KAPL-2220) A VARIATIONAL PROCEDURE FOR CALCULATING FAST FEW-GROUP CONSTANTS. P. A. Ombrellaro and F. D. Federighi (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 10, 1962. Contract W-31-109-eng-52. 46p.

A variational procedure for calculating fast-energy few-group constants is described. For a given medium, the method permits the flux and current solutions of the Boltzmann equation, treated according to P-1 slowing-down theory in each group of a few-group scheme as a linear combination of two base flux spectra to be expressed, the group flux to be obtained, and as a linear combination of two base current spectra, the group current to be obtained. The coefficients for combining the base spectra are provided by the theory and depend only on the concentrations of the component elements of the medium. Once the flux and current spectra in each group are calculated, the group constants for the medium can be easily calculated from base-flux-spectra weighted library microscopic cross sections. Group constants calculated in this manner agree well with those obtained from the MUFT 5 program. (auth)

**5299** (LA-2743) LIFETIME OF NEUTRONS IN REFLECTORS. Kenneth M. Kupferberg (Los Alamos Scientific Lab., N. Mex.). Mar. 1946, Revised Sept. 1962. Contract W-7405-eng-36. 67p.

The mean lifetime of neutrons from a D-D source was measured in U, WC, and BeO reflectors by introducing a short burst of neutrons into the center and observing the subsequent time distribution. The percentage of $U^{235}$ fissions delayed was determined for each of these reflectors, and conclusions were drawn concerning the relative effectiveness of the three materials. (auth)

**5300** (NRL-5851) DETERMINATION OF THE J-VALUES OF s-TYPE NEUTRON RESONANCES BY MULTIPLE SCATTERING. PART 2. S. Podgor and A. W. Sáenz (Naval Research Lab., Washington, D. C.). Oct. 29, 1962. 5p.

A continuation of an earlier Monte Carlo study (NRL Report 5592, February 17, 1961) on the relevance of multiple scattering measurements in determining the J-values of s-type neutron resonances of a predominantly scattering variety is reported. Monte Carlo calculations were carried out for unpolarized neutrons incident on unpolarized targets with plane-parallel slab geometry. The major part of these computations deal with "general" values of the pertinent nuclear parameters, rather than with values corresponding to specific nuclei. These values bracket the ones previously used. For the resonances of interest here, it is found that the ratio B/F of neutrons scattered in the backward direction to those (scattered and unscattered) traveling in the forward direction is strikingly insensitive with respect to changes of the relevant parameters. These results and the previous ones furnish strong indications that only a rough knowledge of $\Gamma\gamma/\Gamma$ and $\Gamma/E_0$ ($E_0$ is the resonance energy) is necessary in principle to determine the J-values of suitable scattering resonances by the measurement of B/F or of similar ratios. The 132-ev resonance of $Co^{59}$ is probably an ideal one for applying the present method. In carrying out the measurement of B/F for this and similar large resonances, our Monte Carlo work indicates that one could employ a nonmonochromatic beam of incident neutrons with an energy spread of about $\Gamma$, essentially centered at $E_0$. (auth)

**5301** (TID-13710) MICROSCOPIC SELF-SHIELDING. Charles H. Randall (Knolls Atomic Power Lab., Schenectady, N. Y.). [1961]. Contract [W-31-109-eng-52]. 47p.

General expressions for microscopic self-shielding factors and effective transport cross sections in heterogeneous materials were obtained by considering solution of the neutron transport equation on a random microgeometry. These results were applied to the particular case of a heterogeneous material consisting of two particle phases distributed in a third matrix phase. A mathematical model for such a material is defined as a function of microstructure parameters and self-shielding factors computed and discussed. The resulting expressions, in the appropriate limits, agree with those of several other authors. The available and possible techniques for measuring the significant microstructure parameters are also discussed. The notion of "homogenization" and its applicability is considered. (auth)

**5302** (TID-15404) SYNTHETIC METHOD SOLUTION OF THE TRANSPORT EQUATION. H. J. Kopp (Knolls Atomic Power Lab., Schenectady, N. Y.). [1962]. Contract [W-31-109-eng-52]. 29p.

A general residue iteration method (the synthetic method) is described and applied to the solution of the neutron transport equation. For example, a synthesis of a sequence of solutions to diffusion equations each having a residue source can constitute such a solution. Only time independent systems consisting of isotropic scattering material of arbitrary geometry are considered herein. Exact solutions, approximate solutions, and the refinement of existing approximate methods can be accomplished within the framework of the synthetic method. (auth)

**5303** (TID-15405) APPLICATIONS OF THE SYNTHETIC METHOD. Harold J. Kopp (Knolls Atomic Power Lab., Schenectady, N. Y.). [1962]. Contract [W-31-109-eng-52]. 31p.

Two applications of the synthetic method to slab geometry problems are described. The first application illustrates a refinement of the $P_1$-approximation (the $K_1$-approximation) which proved to be effective. Next, the exact and approximate solutions to a monoenergetic problem were derived. An illustration of both applications is presented through the evaluation of a solution of a particular problem. (auth)

**5304** RECIPROCITY THEOREMS FOR THERMAL NEUTRONS. I. Kuščer (Univ. of Ljublijana, Yugoslavia). J. Nucl. Energy, Pt. A and B, 16: 379-82(Aug. 1962). (In English)

Reciprocity theorems of Chandrasekhar and Case are generalized to cases when neutrons are in thermal interaction with a medium of uniform temperature. Application of these theorems to Milne's problem leads to certain relations for the function describing the angular and velocity distribution of the emerging neutrons. This function is further used to express the transmissivity of a thick nonabsorbing slab. (auth)

**5305** ON THE DECAY OF NEUTRONS IN A SUBCRITICAL ASSEMBLY. V. C. Boffi, V. G. Molinari, and D. E. Parks (Comitato Nazionale per l'Energia Nucleare, Rome). J. Nucl. Energy, Pt. A and B, 16: 395-403(Aug. 1962). (In English)

Some aspects of the decay of the persisting neutron distribution in a large subcritical assembly are discussed. The problem of finding a relation between the decay constant and the criticality factor is considered. The problem of the boundary condition in a finite system is also treated. (auth)

**5306** COOLANT TEMPERATURE COEFFICIENT AND TWO-THERMAL GROUP DIFFUSION MODEL. A. Kind and G. Rossi (C.C.R.-Euratom, Ispra, Italy). J. Nucl. Energy, Pt. A and B, 16: 423-4(Aug. 1962). (In English)

The two-thermal-group approximation of the type proposed by Selengut (1958, 1961) is used to analyze the rethermalization of neutrons due to the scattering interaction with the hot coolant. (L.T.W.)

**5307** NEUTRON SLOWING DOWN IN THE THERMAL COLUMN OF AN EXPONENTIAL EXPERIMENT. R. Caro (Junta de Energia Nuclear, Madrid). J. Nucl. Energy, Pt. A and B, 16: 424-5(Aug. 1962). (In English)

An expression is derived for the total number of neutrons slowed down to thermal energies in a cylinder (thermal column). (L.T.W.)

**5308** DETERMINATION OF DIFFUSION HARDENING IN WATER. Eugene Starr and Juan Koppel (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 14: 224-9 (Nov. 1962). (BNL-5704)

Diffusion lengths have been measured in $H_2O$ as a function of boric acid concentration. From these measurements of diffusion lengths, the diffusion parameters of water were determined by an improved method of analysis. The diffusion parameters for water reported are: the microscopic absorption cross section $\sigma_a = 326.9 \pm 1.6$ mb, the diffusion coefficient $\overline{D\nu} = 35{,}850 \pm 100\ cm^2/sec$ and the diffusion hardening coefficient $\overline{D\nu}\ H = 2900 \pm 350\ cm^4/sec$. (auth)

**5309** THE DANCOFF CORRECTION IN GAP GEOMETRY. W. Rothenstein and J. Helholtz (Israel Inst. of Tech., Haifa). Nucl. Sci. Eng., 14: 239-43(Nov. 1962).

The Dancoff correction for fuel rods surrounded by air gaps arranged in a hexagonal lattice in a moderator is calculated as a function of the rod radius measured in units of moderator mean free paths, the moderator to fuel volume ratio, and the width of the air gap relative to the radius of the rod. It is found that the Dancoff correction increases with the width of the air gap, when the other parameters are kept constant. This leads to a decrease of the mean chord length in the moderator and consequently a slight increase of the resonance escape probability, whose magnitude may be estimated from the simplest formula for the effective resonance integral. (auth)

**5310** RESONANCE ABSORPTION OF NEUTRONS IN LUMPS WITH NONUNIFORM TEMPERATURE DISTRIBUTIONS. Joel H. Ferziger (Stanford Univ., Calif.). Nucl. Sci. Eng., 14: 244-8(Nov. 1962).

An extension of the methods for computing resonance integrals to the case of nonuniform temperature distributions in the absorber is given. Formally, the procedure is quite similar to previous work and utilizes the same approximations: absorbed neutrons are broken into two groups according to whether their previous collisions were in the absorber or in the moderator; both the narrow resonance and infinite mass approximations are developed. The effect of nonuniform temperature distribution is to modify the escape probabilities required. The calculation requires escape probabilities for lumps which contain nonuniform sources and/or cross sections. Methods of computing these escape probabilities are presented. (auth)

**5311** DIFFUSION ANISOTROPY IN SINGLY- AND DOUBLY-PERIODIC LATTICES. J. R. Beeler (General Electric Co., Cincinnati). Nucl. Sci. Eng., 14: 254-65(Nov. 1962).

Monte Carlo computational experiments were used to study the diffusion anisotropy of fast and slow neutrons in singly- and doubly-periodic, two-region reactor lattices. In two-region systems, it is shown that the separation of the anisotropy factor into a part representing mean free path discontinuity and a part representing absorption probability discontinuity is physically meaningful. In the singly-periodic lattice, the anisotropy factor for fast neutrons was greater than unity, while that for slow neutrons was less than unity. It is possible, however, for the slow neutron anisotropy factor to exceed unity in doubly-periodic lattices. The anisotropy extreme, in the singly-periodic lattice, occurred when the albedo of the moderator slab was equal to that of the fuel slab. (auth)

**5312** AN ANALYTIC APPROACH TO TWO-DIMENSIONAL REACTOR THEORY. H. L. Garabedian and D. H. Thomas (General Motors Research Labs., Warren, Mich.). Nucl. Sci. Eng., 14: 266-71(Nov. 1962).

An analytic method has been developed for the solution of the two-group diffusion equations in a two-dimensional fully reflected reactor. The particular reactor configuration studied is a rectangular core surrounded by a rectilinear reflector, that is, a rectangle within a symmetrically located rectangle. The method involves expansions of each of the fluxes in a double series of eigenfunctions valid over the entire reactor. (auth)

**5313** DISCRETE ORDINATE QUADRATURES FOR THIN SLAB CELLS. David Meneghetti (Argonne National Lab., Ill.). Nucl. Sci. Eng., 14: 295-303(Nov. 1962).

Fluxes of thin slab cells calculated by discrete SN method, DSN(N = 2, 4, 8, 16), single-spherical harmonics, PN(N = 1, 3, ···, 11, 13), and double-spherical harmonics, DPN(N = 1, 2, 3, 4, 5), are compared. The anisotropic flux component occurs predominantly in the region about $\mu = 0$. The spatially dependent part of the spatial flux is largely determined by a few nearest-neighbor source regions. The anisotropic flux component originates largely from the isotropic effective sources arising from the nonspatially dependent part of the spatial flux. Two quadrature forms, for use in discrete ordinate methods of solutions for thin cells, are described which emphasize the small $|\mu|$ directions. One is based on a simplified integral transport approximation. The other is a modified form of the single Gaussian quadrature. Methods of choosing the quadratures and representative results are discussed. (auth)

**5314** EFFECTIVE RESONANCE INTEGRAL DEPENDENCE ON THE MODERATOR SLOWING DOWN PROPERTIES. A. Kirchenmayer (Technische Hochschule, Stuttgart). Nucl. Sci. Eng., 14: 312-14(Nov. 1962).

It is shown by exact calculation of the resonance absorption in an infinite homogeneous mixture for resolved resonances of $U^{238}$ how far the moderator slowing down properties and the interference scattering actually influence the effective resonance integral and its temperature coefficient. Results are compared with the narrow resonance and narrow resonance infinite mass absorber approximations. (W.D.M.)

**5315** VELOCITY DEPENDENT NEUTRON TRANSPORT THEORY WITH HIGH ENERGY SOURCES. Arne Claesson (Aktiebolaget Atomenergi, Tystberga, Sweden). Nucl. Sci. Eng., 14: 314-16(Nov. 1962).

In a recent paper (Conkie, W. R., Nuc. Sc. and Eng., 7: 295) described a method of finding analytic approximate solutions to the Boltzmann equation dependent on both position and energy. The method was confined to the problem of thermal neutrons. The method is extended to cover the case where high energy neutrons are produced in the moderator. (W.D.M.)

**5316** EFFECT OF BRAGG CUTOFF ON THE DIFFUSION OF THERMAL NEUTRONS IN A FINITE SOLID MEDIUM. S. Sanatani (Atomic Energy Establishment, Trombay, India). Nucl. Sci. Eng., 14: 318(Nov. 1962).

In an earlier paper (Sanatani, S. and Kothori, L. S., Nucl. Sci. and Eng., 11: 211-217) some numerical errors in the values of average energy transfer cross sections for Be at 100°K have been detected, which affect considerably the parameters and the general results obtained. A recalculation of the problem with corrected constants was done for a Be slab of thickness 198.72 cm at 100°K. An improvement in the formula for the average diffusion constant was also introduced. (W.D.M.)

**5317** SCATTERING OF NEUTRONS BY AN ANHARMONIC CRYSTAL. A. A. Maradudin and A. E. Fein (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 128: 2589-2608(Dec. 15, 1962).

The one-photon differential scattering cross section for the coherent scattering of thermal neutrons by an anharmonic Bravais crystal is obtained correct to the lowest nonvanishing order in the anharmonic force constants. Cubic and quartic anharmonic terms are retained in the crystal's Hamiltonian. It is found that the $\delta$-function peaks in the energy distribution of the scattered neutrons for a fixed momentum transfer (which occur at the unperturbed phonon energies) in the harmonic approximation are broadened and their positions are shifted in an anharmonic crystal. Some numerical results for the magnitudes of the phonon widths and shifts are obtained for a simple model of a face-centered cubic crystal. (auth)

**5318** THEORY OF MAGNETOVIBRATIONAL SCATTERING OF SLOW NEUTRONS IN A UNIAXIAL ANTIFERROMAGNET. V. N. Kashcheev (Inst. of Physics, Riga, Latvian SSR). Soviet Phys.-Solid State (English Transl.), 4: 1054-60(Dec. 1962).

The energy distribution of one-phonon magnetovibrational scattering of slow neutrons in uniaxial antiferromagnets is considered. The broadening and shift of the peaks of this distribution as a result of the magnon-phonon interaction are determined. (auth)

**5319** DETERMINATION OF THERMAL NEUTRON ABSORPTION AND SCATTERING CROSS-SECTIONS OF RARE GASES. R. Génin, H. Beil, R. Joly, M. Ribrag, and C. Signarbieux (Centre d'Études Nucléaires, Saclay, France). p.219-23 of "Pile Neutron Research in Physics." Vienna, International Atomic Energy Agency, 1962. (CEA-2170)

The EL 2 reactor crystal spectrometer was used to measure the total cross-sections of rare gases as a function of neutron energy in the range of about $10^{-3}$ ev to $10^{-2}$ ev. For such elements the law of total cross section variation observed can be interpreted easily and permits the determination of absorption and scattering cross sections. The accuracy of the procedure is discussed and the results obtained are submitted. (auth)

## Nuclear Properties and Reactions

**5320** (AE-81) THE RESONANCE INTEGRAL OF NIOBIUM. E. Hellstrand, G. Lundgren (Aktiebolaget Atomenergi, Studsvik, Sweden). Aug. 1962. 15p.

The resonance integral of niobium was studied by both pile oscillator and activation techniques. A value of 8.15 b ± 0.65 b was obtained for the infinitely dilute integral. In addition, the variation of the resonance integral with foil thickness was measured for thicknesses in the range 0.06 mm to 1.36 mm. A separate study of the half life of the isomeric state in $Nb^{94}$ yielded a value $T_{1/2} = 6.30 \pm 0.03$ m which is about 5% lower than the value given in literature. (auth)

**5321** (BRL-Memo-1392) PRELIMINARY ASSIGNMENT OF $Si^{28}$ EXCITED STATES. John D. Baldeschwieler, Thomas R. Jeter, and Kenneth Wallgren (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Apr. 1962. 24p. (AD-276844)

The gamma-ray cascades from the $Al^{27}(p,\gamma)Si^{28}$ reaction were used to study the 12.544, 12.911, and 12.918-Mev excited states of $Si^{28}$. Measurements of the low-energy gamma rays are presented for the first time. (auth)

**5322** (NP-12258) THE $Li^6(d,\alpha)\alpha$ REACTION. G. S. Mani, F. Picard, A. Sadeghi (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay); and J. M. F. Jeronymo (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). Aug. 29, 1962. 13p. (Notas de Fisica Vol. IX, No. 18 (p.357-68)).

The $Li^6(d,\alpha)\alpha$ reaction was studied up to 5 Mev deuteron energy. A level in $Be^8$ at 25.3 Mev excitation was observed having probably $J = 2^+$ and $T = 0$. (auth)

**5323** (NYO-8921) A SYSTEMATIC STUDY OF (p,xp) REACTIONS IN THE 100-400 Mev REGION (thesis). David Lee Morrison (Carnegie Inst. of Tech., Pittsburgh). June 2, 1961. Contract AT(30-1)-844. 96p.

A systematic study of (p,xp) reactions ($2 \le x \le 5$) was undertaken to aid in the elucidation of nuclear reaction mechanisms in the 100 to 400 Mev region. Excitation functions for (p,xp) reactions were measured on the following target nuclei: $Si^{30}$, $P^{31}$, $S^{32}$, $V^{51}$, $Zn^{68}$, $As^{75}$, $W^{186}$, and $Re^{187}$. The observed (p,2p) cross sections were found to be relatively insensitive to the mass of the target nuclide while the (p,3p) and (p,4p) cross sections generally decreased as the mass of the target increased. The observed (p,2p) and (p,3p) cross sections were compared with values calculated from Monte Carlo data. Cross sections for (p,2p) reactions were also calculated based on a geometrical model. The behavior of the recoiling product nuclei from the $Zn^{68}(p,2p)Cu^{67}$ reaction was studied. Theoretical estimates of the kinetic energies of the fragments based on a pure knock-on or a (p,p′) evaporation mechanism were lower than the observed values. Although the (p,xp) reactions are reasonably consistent with a pure knock-on mechanism in this energy region, two additional complementary mechanisms were suggested to explain some of the experimental observations. (auth)

**5324** (NYO-9286) MEASUREMENTS OF NEGATIVE MUON LIFETIMES IN LIGHT ISOTOPES (thesis). Morton Eckhause (Carnegie Inst. of Tech., Pittsburgh). Feb. 1962. Contract AT(30-1)-882. 68p.

Negative muons from the Carnegie Tech synchrocyclotron were stopped in the following targets: separated isotopes of lithium ($Li^6$ and $Li^7$) and of boron ($B^{10}$ and $B^{11}$), as well as natural beryllium, carbon, and oxygen. From an analysis of the corresponding time spectrum of the decay electrons, the negative muon lifetime in each of these substances was obtained. From a separate measurement of the $\mu^+$ lifetime (2.202 ± 0.004 μsec), the capture rates in the above elements were determined. They are (in units of $10^5$/sec): $\lambda_c(Li^6) = 0.111 \pm 0.013$, $\lambda_c(Li^7) = 0.028 \pm 0.013$, $\lambda_c(Be) = 0.11 \pm 0.02$, $\lambda_c(B^{10}) = 0.273 \pm 0.015$, $\lambda_c(B^{11}) = 0.227 \pm 0.016$, $\lambda_c(C) = 0.394 \pm 0.011$, and $\lambda_c(O) = 0.97 \pm 0.03$. (auth)

**5325** (PUC-1962-62) THE POSITRON DECAY OF $Sc^{42}$, $V^{46}$, $Mn^{50}$, $Co^{54}$, AND $Cu^{58}$. John H. Miller, III and David C. Sutton (Princeton Univ., N. J. Palmer Physical Lab.). Feb. 20, 1962. Contract [AT(30-1)-937]. 5p.

Measurements were made of the positron end-point energies and half lives of the transitions $Sc^{42} \rightarrow Ca^{42}$, $V^{46} \rightarrow Ti^{46}$, $Mn^{50} \rightarrow Cr^{50}$, $Co^{54} \rightarrow Fe^{54}$, and $Cu^{58} \rightarrow Ni^{58}$. (M.C.G.)

**5326** (UCRL-10474) SPONTANEOUS FISSION OF THE HEAVIEST ELEMENTS. Sven A. E. Johansson (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 25, 1962. Contract W-7405-eng-48. 22p.

The spontaneous-fission rates of nuclei with $Z \ge 98$ have been calculated. Deviations of these fission rates from the general trend predicted by the liquid-drop model are attributed to the fine structure of the single-particle level diagram. Calculations reproduce the experimental values reasonably well, particularly the rapid drop in half-life with increasing neutron number just above neutron number 152. Contrary to previous predictions, results show that this drop is a local effect and that the half lives soon start to increase with increasing neutron number. Heavy, neutron-rich nuclei therefore have considerable stability against spontaneous fission. Based on the predicted half lives, the possibilities of producing very heavy nuclei are discussed. The half lives indicate that prolonged neutron irradiation or heavy-ion bombardment are not very promising methods of producing very heavy nuclei because of the short fission half lives of the reaction products. The most promising method appears to be production by means of nuclear explosions. The implications of the present results for neutron capture in supernovae explosions are discussed. An interpretation of the light curves of Type I supernovae is given. (R.J.S.)

**5327** ELASTIC AND INELASTIC NEUTRON SCATTERING ON $S^{32}$ AT 4.6 Mev. N. Martalogu, I. Neamu, and M. Ivascu (Inst. of Nuclear Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 283-8(1962). (In Rumanian)

Fast neutrons produced in $H^3(p,n)He^3$ reactions and scattered on a spherical sulfur diffuser were measured with a 200 μ NIKFI nuclear emulsion (in the presence of a strong γ background) in order to determine the angular distribution of elastic and inelastic neutron scattering at 4.6 Mev. (tr-auth)

**5328** THE THEORY OF THE γ-γ ANGULAR CORRELATION IN COMBINED MAGNETIC AND INHOMOGENEOUS ELECTRICAL FIELDS. I. THE GENERAL FORM OF THE CORRELATION FUNCTION. Harry Paul and Witlof Brunner (Deutschen Akademie der Wissenschaften, Berlin). Ann. Physik, 7: 316-22(1962). (In German)

The general form of the correlation function in the formalism of Biedenharn and Rose was derived for the interaction with random (static) external fields. (tr-auth)

**5329** THE THEORY OF γ-γ ANGULAR CORRELATION IN COMBINED MAGNETIC AND INHOMOGENEOUS ELECTRICAL FIELDS. II. THE INTERACTION OPERATOR. Harry Paul and Witlof Brunner (Deutschen Akademie der Wissenschaften, Berlin). Ann. Physik, 7: 323-9(1962). (In German)

The matrix elements of the interaction operators are given and discussed with respect to their dependence on the angle and the signs of the interaction. The relationships derived for the coefficients of the correlation function were investigated approximately. (tr-auth)

**5330** SOME PROPERTIES OF THE LEVELS OF $_{100}Fm^{254}$. J. M. Hollander, C. L. Nordling, and K. Siegbahn (Univ. of California, Berkeley). Arkiv Fysik, 23: 35-40 (1962). (UCRL-10123). (In English)

Measurements were made of the energies and intensities of the E2 transitions which de-excite the gamma (K = 2) vibrational band in $Fm^{254}$ following beta decay of 38.5 hour $E^{254}$. The measured relative intensities were interpreted within the framework of the Bohr-Mottelson nuclear model, including the effect of mixing of the K = 2 and K = 0 ground bands. It was found that the rotation–vibration constant of the ground state band is very small [$B = (-0.4 \pm 1.8) \times 10^{-3}$ kev] and can be accounted for completely by the (K = 2) mixing amplitude calculated from the intensity data. (auth)

**5331** A GENERALIZED ROTATION-VIBRATION MODEL FOR DEFORMED EVEN NUCLEI. S. A. Williams and J. P. Davidson (Rensselaer Polytechnic Inst., Troy, N. Y.). Can. J. Phys., 40: 1423-35(Oct. 1962).

The generalized rotation-vibration interaction problem for deformed even nuclei whose surface can be well represented by a single order spherical harmonic $Y_{\lambda,\mu}$ has been solved for all λ. The conditions which allow the resulting Schrödinger equation to separate into rotation and vibration parts is stated and approximate solution for the latter is given which depends upon the rotational energy eigenvalues, $\epsilon^{\lambda}_{I,N}$. A graphical method for obtaining the energy eigenvalues of the interacting system for all values of λ is developed which is accurate to about 1% and is applied to the positive and negative parity levels of $Th^{228}$. A table of the $\epsilon^{3}_{I,N}$ for $I \leq 12$ necessary for the negative parity calculations is appended. (auth)

**5332** DISTORTION OF THE TRITON CORE IN THE HYPERNUCLEUS $_{\Lambda}H^4$. C. Roth and R. T. Sharp (McGill Univ., Montreal). Can. J. Phys., 40: 1457-60(Oct. 1962).

The Λ-nucleon potential effective in $_{\Lambda}H^4$ is estimated by means of a wave function which allows the nuclear core a radial expansion and a spheroidal distortion correlated with the instantaneous Λ-core distance. The inclusion of such distortions reduces by about 13% the Λ-nucleon potential required to fit the observed binding energy. (auth)

**5333** SOME ATOMIC MASSES AND NEUTRON SEPARATION ENERGIES FOR ISOTOPES OF TIN AND ANTIMONY. R. C. Barber, R. L. Bishop, L. A. Cambey, W. McLatchie, and H. E. Duckworth (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 40: 1496-7(Oct. 1962).

Absolute masses for the nuclides $Sn^{116}$, $Sn^{117}$, $Sn^{118}$, $Sn^{119}$, $Sn^{120}$, $Sn^{122}$, $Sn^{124}$, $Sb^{121}$, and $Sb^{123}$ are given. Neutron separation energies are tabulated for $Sn^{117}$, $Sn^{118}$, $Sn^{119}$, $Sn^{120}$, $Sn^{121}$, $Sn^{122}$, $Sn^{123}$, $Sn^{124}$, $Sb^{122}$, and $Sb^{123}$. Results are compared with other recent work. (W.D.M.)

**5334** TIME-OF-FLIGHT FISSION STUDIES ON $U^{233}$, $U^{235}$, AND $Pu^{239}$. J. C. D. Milton and J. S. Fraser (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 40: 1626-63(Nov. 1962).

The prompt mass and kinetic energy distributions resulting from the thermal neutron fission of $U^{233}$, $U^{235}$, and $Pu^{239}$ have been reinvestigated using time-of-flight methods to measure simultaneously the velocities of the fragment pairs. A new feature shown is the existence of fine structure in the prompt mass yields. This fine structure is most pronounced at high total kinetic energies where the fragments have little excitation energy and may be associated with irregularities in the energy release as a function of mass. The fine structure is most noticeable in $U^{235}$ and least in $Pu^{239}$; the fragments of $U^{235}$ have the lowest average excitation and those of $Pu^{239}$, the highest. Another feature is the large drop in total kinetic energy when the fragments are near symmetry. This decrease is about 35 Mev and is consistent either with a picture in which the nucleus with 50 protons is especially preferred or with one in which fragments at symmetric fission have an abnormally high excitation energy and a consequent large number of neutrons. The mean kinetic energies for thermal neutron fission of $U^{233}$, $U^{235}$, and $Pu^{239}$ were found to be 167.6, 168.3, and 175.0 Mev with an error of ±1.7 Mev. (auth)

**5335** LIFETIMES OF EXCITED NUCLEAR STATES IN $Xe^{131}$ AND $Pb^{208}$. R. S. Weaver (McGill Univ., Montreal). Can. J. Phys., 40: 1684-6(Nov. 1962).

Results obtained from a program of lifetime measurements by delayed coincidence are described. The mean life of the 80 kev level of $Xe^{131}$ was found to be $7.15 \pm 0.30 \times 10^{-10}$ sec, and the mean life of the 3.2-Mev level of $Pb^{208}$ was found to be $4.30 \pm 0.25 \times 10^{-10}$ sec. (W.D.M.)

**5336** SPALLATION PRODUCTS DISTRIBUTED IN A THICK IRON TARGET BOMBARDED BY 3-Bev PROTONS. Masatake Honda (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 67: 4847-58(Nov. 1962).

The distribution of several spallation products, covering a wide range of atomic number, has been measured in a thick iron target (30 × 30 × 90 cm) bombarded by 3-Bev protons at the Brookhaven cosmotron. Measurements were made of the radioactivity of γ-, β-, and x-ray emitters, either directly or after chemical separation, in iron and nickel foils placed at different depths. Products such as Co isotopes in Ni and $Fe^{55}$, $Mn^{54}$, and $Cr^{51}$ in Fe, which are close to the target mass, were produced in important amounts at large angles to the primary beam. Production of nuclides of lower A showed gradually better collimation, $Na^{22}$ and $Be^7$ showing the smallest spread. These data provide useful information on the production rates of cosmogenic nuclides in meteorites and on their variation with depth and size. The results of this experiment may be compared with the available meteorite data and with other calculations. (auth)

**5337** TRITIUM IN THE THERMAL NEUTRON FISSION OF URANIUM-235. E. N. Sloth, D. L. Horrocks, E. J. Boyce, and M. H. Studier (Argonne National Lab., Ill.). J. Inorg. & Nucl. Chem., 24: 337-41(Apr. 1962). (TID-14172). (In English)

The existence of tritium as a product of fission, first reported by Albenesius, was verified. A ratio of 1.25 ± 0.15 × $10^4$ fissions per atom of tritium was found for the thermal neutron-induced fission of $U^{235}$. Tritium was converted to water in a closed system and its activity measured by liquid scintillation techniques. The number of fissions was determined by assay of the 0.537-Mev $\gamma$ ray of $Ba^{140}$. (auth)

**5338** TEST OF RELATIVE VALUES OF DIFFERENTIAL CROSS SECTIONS FOR EMISSION OF TRITONS IN THE REACTION $Li^6(n,t)He^4$ FOR ENERGIES OF 150, 200, AND 250 Kev. C. Beets (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium), E. Donneaux, G. Gierts, and L. Winand. J. Nucl. Energy, Pt. A and B, 16: 383-6(Aug. 1962). (In French)

The differential neutron cross sections of the reaction $Li^6(n,t)He^4$ published by Roberts and Kinney (1957) are not in agreement with those determined by Martin Jr. et al., (1959). An experiment was realized to test both sets of results for $E_n$ = 200 and 250 kev, and also the values for $E_n$ = 150 kev obtained by Martin. For the differential neutron cross sections the results correspond best with those of Martin. (auth)

**5339** PROTONS FROM SEVERAL ELEMENTS BOMBARDED WITH 30-Mev ALPHA PARTICLES. Isao Kumabe, Takesi Komatuzaki, Shigeharu Tomita, Tetsuji Yamaki, and Yasumasa Yamada (Kyoto Univ.). J. Phys. Soc. Japan, 17: 1526-35(Oct. 1962).

Thin targets of Al, Cu, Ag, and Au were bombarded with the 30-Mev alpha particles and the energy distributions of protons were measured at angular intervals of 10 or 15°. From an analysis of the energy distributions, the angular distributions for each 2-Mev energy interval were obtained. General behaviors of the angular distributions are as follows. (1) The cross-section increases smoothly from back to forward angles. (2) The forward peaking of the cross-section is greater at low excitation energy of the residual nucleus than at high excitation energy. (3) The forward peaking is more pronounced for heavy elements than for light ones except for Au. From an analysis of the energy distributions at 135° in laboratory system, the relative level densities of the residual nuclei were obtained as a function of the excitation energy of the residual nucleus. The curves on semilog plots of the level densities show the parabolic behavior which is predicted by the level density formula coming from the Fermi gas. (auth)

**5340** PHOTOPROTONS FROM ALUMINIUM. Katsufusa Shoda (Tohuku Univ., Sendai), Takeo Ishizuka, Koichi Shimizu, and Makoto Akashi. J. Phys. Soc. Japan, 17: 1536-41(Oct. 1962).

The energy and angular distributions of photoprotons from aluminum induced by 24 Mev bremsstrahlung were measured using nuclear emulsions. Many proton peaks were observed in the energy distribution. The energies of these peaks were compared with the results of calculations and experiments on $(\gamma,n)$. The proton peaks from direct transitions between intrinsic single particle levels in deformed nucleus were calculated and they are too few to explain all the structures in the energy distribution. If the structures are neglected, the observed energy distribution agrees well with the calculated one using the statistical theory. The angular distributions were compared with the calculations of compound process and direct process. They suggest that protons are emitted by compound process in low energy and by direct process with d or lower orbital angular momentum in high energy. (auth)

**5341** STRUCTURE OF GIANT RESONANCE IN $Al^{27}(\gamma,n)$ REACTION. Naoshi Mutsuro, Kosuke Kageyama, Masanori Mishina, Takemi Nakagawa, Eiji Tanaka, and Motoharu Kimura (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 17: 1672-3(Oct. 1962).

The $Al^{27}(\gamma,n)$ cross section was measured up to 24 Mev with good energy resolution. Using a 25 Mev betatron, the yield of photoneutrons from $Al^{27}$ was determined for bremsstrahlung with peak energies ranging from 12.5 to 24 Mev in steps of 0.25 and 0.1 Mev. Neutrons were detected with eight $B^{10}$ enriched $BF_3$ counters in parrafin. (W.D.M.)

**5342** ON THE STUDY OF $P^{31}(\gamma,n)$ AND $S^{32}(\gamma,n)$ REACTION. Naoshi Mutsuro, Kosuke Kageyama, Masanori Mishina, Eiji Tanka, and Motoharu Kimura (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 17: 1673-4(Oct. 1962).

Photoneutron cross sections of $P^{31}$ and $S^{32}$ were measured up to 24 Mev by using bremsstrahlung from a 25 Mev betatron. Each neutron yield point was the result of four or five measurements involving a count of about $10^4$ for each point. Cross section curves and characteristic constants are shown. (W.D.M.)

**5343** PHOTOPROTONS FROM SODIUM. Masatoshi Odera (Tokyo Inst. of Tech.). J. Phys. Soc. Japan, 17: 1675(Oct. 1962).

The energy and angular distributions of photoprotons from sodium irradiated with 18 Mev bremsstrahlung were measured. Protons were detected by nuclear emulsions 200 $\mu$ thick placed radially around the target. The energy spectrum is shown in 200 kev intervals. Peaks were obtained at 7.2, 6.3, 5.3, 4.9, and 3.9 Mev. (W.D.M.)

**5344** CROSS SECTIONS OF $Cl^{35}(\gamma,n)Cl^{34}$ AND $S^{32}(\gamma,n)S^{31}$ REACTIONS. Katsumi Kuriyama (Tokyo Univ.). J. Phys. Soc. Japan, 17: 1681-8(Nov. 1962). (In English)

Photoneutron cross sections of $Cl^{35}$ and $S^{32}$ have been studied with a 30 Mev betatron by measuring the induced activity yields of $Cl^{34}$ and $S^{31}$ respectively. Yields were measured by flow method to suppress activities from other types of reactions. The cross sections of the two reactions attain maxima at 19.8 and 20.5 Mev, their values being 13.5 and 13.6 mb, respectively. The widths of the giant resonance curves are 6.5 and 6.3 Mev and the integrated cross sections are 93 and 86 Mev-mb, respectively. In the yield curve of Cl, breaks were observed at 13.8, 14.1, 15.1, 16.2, 17.6, and 18.2 Mev, and in the case of S at 16.2 and 17.0 Mev. (auth)

**5345** THE ENERGY SPECTRUM OF PHOTOPROTONS FROM $Ne^{20}$. Baik Nung Sung (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 17: 1811-12(Nov. 1962). (In English)

The energy spectrum of photoprotons from $Ne^{20}$ at 23.5 Mev was detected by Sakura NR-M1 emulsions which were placed in a scattering gas chamber parallel to the x-ray beam. The gas chamber was filled with natural neon gas at a pressure of 3.09 atm. The number of observed proton tracks was 4345 in the scanned area of 3.59 cm. (W.D.M.)

**5346** RESONANCE WIDTHS FOR PROTON CAPTURE—A GRAPHICAL METHOD. A. W. Borgi and O. Loensjoe (Univ. of Oslo). Nucl. Instr. Methods, 17: 31-2(Sept. 1962). (In English)

The interquartile range of the thick target yield curve is given graphically as a function of the nuclear level width and of the standard deviation of the proton beam energy distribution (assumed Gaussian). The effect of straggling in target is ignored. The graph can be used to find the level width from the observed width of the yield curve when the proton energy spread is known. (auth)

**5347** MEASUREMENT OF (γ,Tn) REACTIONS INDUCED BY MEANS OF A 100 Mev SYNCHROTRON. S. Costa and S. Ferroni (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nucl. Instr. Methods, 17: 145-8(Oct. 1962). (In English)

The apparatus and techniques employed to determine the excitation functions of the (γ,tn) reactions in several elements up to 80 Mev are described. The Turin 100 Mev synchrotron was used to produce the gamma radiation. The neutron detector, gate triggering, oscillating circuit, and synchrotron energy calibration are discussed. (H.D.R.)

**5348** NEUTRON BACKGROUND DUE TO Ta BACKINGS FOR LITHIUM TARGETS. C. T. Hibdon (Argonne National Lab., Ill.). Nucl. Instr. Methods, 17: 177-80 (Oct. 1962). (TID-16198). (In English)

The background due to neutron scattering from the tantalum backing for lithium targets has been measured at neutron energies from 2 to 300 kev for neutrons emitted at an angle of 120° with respect to the direction of the proton beam. The method consists in measuring the unfiltered neutron flux in this direction with and without a second piece of tantalum attached to the backing of the targets and making the appropriate transmission corrections for the scattered neutrons. The background fraction is large at low energies but falls steeply with increasing neutron energy to about 6.5% at 10 kev. It subsequently decreases gradually to about 2.8% at 100 kev, where it begins to rise again and reaches a maximum of about 6.3% at 250 kev. (auth)

**5349** POLARIZATION OF PROTONS IN ELASTIC SCATTERING BY $O^{16}$ AND $C^{12}$. S. Gorodetzky, J. Ullman, G. Bergdolt, and A. Gallmann (Institut de Recherches Nucléaires, Strasbourg). Nucl. Phys., 38: 177-85(Oct. 1962). (In French)

The polarization of protons elastically scattered from $O^{16}$ and $C^{12}$ was measured at a laboratory scattering angle of 51.5° and bombarding energies between 3.76 and 4.65 Mev. The double-scattering method was used, i.e., protons polarized by scattering from carbon were analyzed by scattering from carbon and oxygen. The measurements were compared with the predictions of phase shift analyses of elastic-scattering angular distributions. The results on $O^{16}$ suggested levels of spin and parity $3/2^-$ and $3/2^+$ at excitation energies 4.60 and 4.97 Mev, respectively, in the compound nucleus $F^{17}$. (auth)

**5350** ORBIT FLIP MAGNETIC TRANSITIONS. H. Morinaga and K. Takahashi (Tokyo Univ.). Nucl. Phys., 38: 186-92(Oct. 1962). (In English)

In well-deformed nuclei it sometimes happens that a magnetic transition between two nuclear single-particle states depends only on the orbit flip of the particle. Two M4 transitions, one in $Hf^{179}$ and one in $Yb^{177}$, which correspond to such a case are found to be inhibited by factors of 2000 and more than 500 respectively. Three more neutron transitions of this type are found that are strongly hindered. Proton transitions of this type, on the contrary, are not hindered at all. This selection rule seems to indicate the absence of an electric current associated with the neutron orbit inside a nucleus. (auth)

**5351** ON THE NUMBER OF NEUTRONS EMITTED BY $U^{236}$ IN THE SYMMETRIC FISSION REGION. V. F. Apalin, Y. N. Gritsyuk, I. Y. Kutikov, V. I. Lebedev, and L. A. Mikaelyan (Kurchatov Atomic Energy Inst., Moscow). Nucl. Phys., 38: 193-5(Oct. 1962). (In English)

The number of ν neutrons emitted by $U^{236}$ is measured for different ratios of the masses of fragments. A sharp increase of ν is detected in the symmetric fission region. The dependence of ν on the mass ratio is in accord with the total kinetic energy of the fragments. (auth)

**5352** HALF-LIFE MEASUREMENTS OF $^{6}$He, $^{16}$N, $^{19}$O, $^{20}$F, $^{28}$Al, $^{77}$Se$^{m}$ AND $^{110}$Ag. S. Malmskog and J. Konijn (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Phys., 38: 196-210(Oct. 1962). (In English)

The half lives of different isotopes are measured with a pulse-height analyzer working in its multiscale mode of operation. A NaI(Tl)-scintillation spectrometer is used as detector. Least-squares analyses are performed for each measurement. The following weighted mean values of the half lives are obtained: $He^{6}$, 0.862 ± 0.017 sec; $N^{16}$, 7.31 ± 0.04 sec; $O^{19}$, 29.1 ± 0.3 sec; $F^{20}$, 11.56 ± 0.05 sec; $Al^{28}$, 2.31 ± 0.01 min; $Se^{77m}$, 18.83 ± 0.04 sec; and $Ag^{110}$, 24.42 ± 0.14 sec. (auth)

**5353** LIFETIMES OF THE FIRST EXCITED STATES OF $B^{10}$, $O^{17}$ AND $F^{17}$. [PART] I. N. H. Gale, J. B. Garg, and J. M. Calvert (Univ. of Manchester, Eng.). Nucl. Phys., 38: 222-51(Oct. 1962). (In English)

The lifetimes of the first excited states of $B^{10}$, $O^{17}$, and $F^{17}$ are measured by the delayed-coincidence method using a pulsed beam. The measured mean lives are: $(1.00 \pm 0.03) \times 10^{-9}$ sec ($B^{10}$), $(4.30 \pm 0.21) \times 10^{-10}$ sec ($O^{17}$), and $(4.29 \pm 0.22) \times 10^{-10}$ sec ($F^{17}$). The chief theoretical treatments of quadrupole enhancement are reviewed, and their predictions compared with the experimental results. (auth)

**5354** LIFETIMES OF THE FIRST EXCITED STATES OF $B^{10}$, $O^{17}$ AND $F^{17}$. II. ANALYSIS OF DELAYED COINCIDENCE LIFETIME MEASUREMENTS. N. H. Gale (Univ. of Manchester, Eng.). Nucl. Phys., 38: 252-8(Oct. 1962). (In English)

An analysis of delayed coincidence measurements is made that enables unambiguous lifetime measurements to be made, even in the case where unknown fractions of prompt radiations or delayed radiations other than that of interest are accepted in the measurement of the delayed coincidence curve. A further analysis is made that enables a delayed coincidence curve to be predicted if the shape of the prompt coincidence curve is known. (auth)

**5355** PHASE SHIFT ANALYSIS OF THE ELASTIC SCATTERING OF PROTONS FROM OXYGEN. R. W. Harris, G. C. Phillips, and C. Miller Jones (Rice Univ., Houston, Tex.). Nucl. Phys., 38: 259-80(Oct. 1962). (In English)

The elastic scattering of protons by $O^{16}$ is investigated in the range of bombarding energies from 3.5 to 5.75 Mev; twelve excitation functions and four angular distributions are measured. A phase-shift analysis of the cross-section data shows the existence of a broad ($\Gamma_{lab}$ = 0.220 Mev) $3/2^-$ state at 4.60 Mev and a very broad ($\Gamma_{lab}$ = 1.0 Mev) $3/2^+$ state at 4.97 Mev in $F^{17}$. In addition the analysis indicates the possible existence of states with assignments $3/2^-$, $7/2^-$, and $3/2^+$ at $F^{17}$ excitations of 5.47, 5.67, and 5.84 Mev, respectively. The $3/2^-$ and $3/2^+$ states at 4.60 and 4.97 Mev are shown to have a fairly large probability of being found in the two-body configuration p + $O^{16}$. (auth)

**5356** FINAL STATE SCATTERING. R. Delbourgo (Imperial Coll., London). Nucl. Phys., 38: 281-99(Oct. 1962). (In English)

Increasing evidence suggests the importance of interactions among the final particles in various production processes. The final state interactions may or may not be strong, and in general take place among all the pairs. Watson's (Phys. Rev. 88: 1163(1952)) theorem is generalized by perturbation theory based on "total potentials" to deal with such situations. A parameter $c \approx 1$ is found in this way, which characterizes the "amount" of final state scattering and which theoretically is a measure of the importance of the virtual processes in relation to the physical process. The result is applied to $K^{\pm}$ decay and two classes of solutions are found on the assumption of S-wave production of the pions: $a_2 \approx 1.5$, $a_0 \approx -0.5$; and $a_2 \approx 0$, $a_0 \approx -0.5$, where the a are scattering lengths in the lengths in the isospin states T = 0 and T = 2. (auth)

**5357** GAMMA RAYS FROM THE INTERACTION OF 14-Mev NEUTRONS WITH LITHIUM. J. Benveniste, A. C. Mitchell, C. D. Schrader, and J. H. Zenger (Univ. of California, Livermore). Nucl. Phys., 38: 300-4(Oct. 1962). (In English)

The cross section for the $Li^7(n,n')Li^{7*} \rightarrow Li^7 + \gamma(0.477$ Mev) reaction is measured near 14 Mev by detecting the gamma rays. A time-of-flight technique is used to distinguish the gamma rays from the high neutron background. The cross section is about 80 mb (±12%) in the neutron energy range 13.6 to 14.3 Mev. Beyond this the data suggest a rise in the cross section to 110 mb at 14.7 Mev. (auth)

**5358** SCATTERING OF ALPHA PARTICLES BY $Zn^{64}$ AND $Zn^{68}$. H. W. Broek, T. H. Braid, J. L. Yntema, and B. Zeidman (Argonne National Lab., Ill.). Nucl. Phys., 38: 305-15(Oct. 1962). (In English)

The elastic and inelastic scattering of 43-Mev alpha particles by $Zn^{64}$ and $Zn^{68}$ is studied. Low-lying groups, with angular distributions in phase with elastic scattering, are found at 1.79 and 2.30 Mev in $Zn^{64}$ and at 1.66 and 1.89 Mev in $Zn^{68}$. These groups are presumably from two-phonon levels. The two-phonon groups from $Zn^{64}$ have about the same cross sections as those from $Ni^{60}$, while those from $Zn^{68}$ have only about a quarter of this value. (auth)

**5359** INELASTIC SCATTERING OF 14.8 Mev NEUTRONS FROM CARBON AND BISMUTH. J. Rethmeier, C. C. Jonker, M. Rodenburg, J. Hovenier, and D. Van der Meulen (Vrije Universiteit, Amsterdam). Nucl. Phys., 38: 322-6(Oct. 1962). (In English)

Inelastic neutron scattering from carbon and bismuth is investigated. A difference between this and inelastic proton scattering is found. (auth)

**5360** AMPLITUDE VERTEX PARTS OF DIRECT NUCLEAR PROCESSES. I. S. Shapiro (Inst. of Theoretical and Experimental Physics, Moscow). Nucl. Phys., 38: 327-43(Oct. 1962). (In English)

The vertex parts are studied on the basis of the optical model. The analytical properties of the vertex part are studied as functions of momentum transfer. It is shown that a singularity at infinity essentially corresponds to the nuclear radius, even in case of a potential well with a diffuse edge. The role of nuclear edge diffusion is analyzed for angular distributions in direct reactions. The estimation of reduced vertex parts, taking into account the dissipation of one-particle states, is discussed. (auth)

**5361** DECAY OF THE NUCLEUS $C^{12}$ CAUSED BY 22 TO 24 Mev $\alpha$ PARTICLES. S. S. Vasilyev, V. V. Komarov, and A. M. Popova (Moscow State Univ.). Nucl. Phys., 38: 344-8(Oct. 1962). (In English)

The decay of the $C^{12}$ nucleus into three $\alpha$ particles under the action of 22- to 24-Mev $\alpha$ particles is studied to determine the reaction mechanisms. Spatial and energy distributions of the decay products, as well as the excitation energies of the possible intermediate nuclei $C^{12}$ and $Be^8$, are given. It is established that the dominating reaction mechanism is the decay of the nucleus $O^{16}$ into four $\alpha$ particles, with a resonance interaction of $\alpha$ particles in the final state. (auth)

**5362** ENERGY LEVELS OF $B^{11}$ IN THE UNIFIED MODEL. A. B. Clegg (Clarendon Lab., Oxford). Nucl. Phys., 38: 353-60(Nov. 1962). (In English)

The unified model of the energy level scheme of $B^{11}$ is described, taking into account the mixing of states of the same angular momentum from different bands. It is shown that the resulting spectrum can explain the systematic features of the $B^{11}(p,p')$ reaction and the $C^{12}(p,2p)$ reaction at 150 to 200 Mev. The spectrum has something of the character of a vibrational spectrum. This relationship to other models is discussed. (auth)

**5363** THE SCATTERING OF 29 Mev $^3$He-PARTICLES BY $^{14}$N AND $^{16}$O NUCLEI. H. M. Sen Gupta (St. Bartholomew's Hospital Medical Coll., London), J. Rotblat, P. E. Hodgson, and J. B. A. England. Nucl. Phys., 38: 361-71 (Nov. 1962). (In English)

The nuclear emulsion technique was employed to study the scattering of 29-Mev $He^3$ particles by $N^{14}$ and $O^{16}$ nuclei. Elastic angular distributions were analyzed in terms of a diffuse surface optical model; good agreement was found up to 50° (cms). The inelastic processes were compared with the predictions of the direct interaction mechanism. (auth)

**5364** THE SCATTERING OF 29 Mev $^3$He-PARTICLES BY C, F, S AND Br NUCLEI. A. García (Univ. of Valencia), J. Kirk, J. B. A. England, and P. E. Hodgson. Nucl. Phys., 38: 372-9(Nov. 1962). (In English)

Angular distributions for the elastic scattering of 29-Mev $He^3$ particles by C, F, S, and Br are obtained using a photographic-plate technique. Absolute differential cross sections in the center-of-mass system are given in the angular range 14 to 80°. The experimental results are analyzed in terms of the optical model of the interaction, and the best-fit parameters of this model are obtained. The results of optical-model analyses of 29-Mev elastic scattering data for a number of elements are discussed. Inelastic scattering and $(He^3,He^4)$ and $(He^3,d)$ reactions are observed for C, and some of the experimental angular distributions obtained are compared with the Butler plane-wave direct-interaction model. (auth)

**5365** SPECTROSCOPIC STUDY OF LOW ENERGY VIBRATIONAL STATES OF SPHERICAL NUCLEI. Shiro Yoshida (Univ. of Pittsburgh). Nucl. Phys., 38: 380-419 (Nov. 1962). (In English)

Nuclear spectroscopic studies of spherical nuclei are presented on the basis of theories of nuclear structure. The starting point is the quasi-particle approximation, which includes the effect of the pairing interaction. Quadrupole and octupole vibrational states are treated. The long-range residual interactions are assumed to be quadrupole-quadrupole and octupole-octupole interactions and independent of the spin and isobaric spin. The interactions are assumed to be effective between any pair of nucleons. Energy spectra of nuclei, electric transition rates, cross sections for inelastic scattering, and spectroscopic factors for stripping and pick-up reactions are calculated. The results are compared with experimental data. (auth)

**5366** A STUDY OF EFFECTIVE NUCLEAR INTERACTIONS IN FINITE NUCLEI. S. K. Shah and S. P. Pandya (Physical Research Lab., Ahmedabad, India). Nucl. Phys., 38: 420-35(Nov. 1962). (In English)

A shell-model analysis of T = 1 levels in the nuclei $Li^6$, $O^{18}$, and $Ti^{50}$ is presented in appropriate configuration space and coupling scheme. The important feature of this analysis is that the matrix elements of various energy states are calculated in terms of the matrix elements of the effective interaction (i.e. the reaction matrix) in two-nucleon states of definite relative orbital angular momentum and total spin. The nature of the effective interactions thus derived is discussed. The results throw some light on possible non-locality and configuration-dependence of the elements of the reaction-matrix in finite nuclei. (auth)

**5367** $O^{16}$(d,p) AND (d,$\alpha$) REACTIONS IN THE ENERGY RANGE 0.8-2.0 Mev. G. Calvi, A. Rubbino, and D. Zubke (Università, Catania, Italy). Nucl. Phys., 38: 436-41(Nov. 1962). (In English)

The differential cross sections at 90° of the reactions $O^{16}(d,p_0)$, $O^{16}(d,p_1)$, and $O^{16}(d,\alpha_0)$ are measured in the energy range 0.8 to 2.0 Mev. All three reactions give evidence of a level of $F^{18}$ at 8.50 Mev. The first two reactions give evidence of a level of $F^{18}$ at 9.00 Mev. A resonance at $E_d$ = 1.80 Mev of the third reaction cannot be attributed with certainty to any 9.14 Mev level. Some properties of the levels are discussed. (auth)

**5368** $\alpha$-INDUCED FISSION OF NEON 20. N. O. Lassen (Univ. of Copenhagen). Nucl. Phys., 38: 442-9 (Nov. 1962). (In English)

A method is described by which the carbon ions from the reaction $Ne^{20}(\alpha,C^{12})C^{12}$ can be detected in the presence of a high background of lighter ions from elastic and inelastic reactions. The cross section is found to be much higher for $\theta_{CM}$ = 90° than for $\theta$ = 122°. Only the ground state transition is seen; no other modes of fission are detected. (auth)

**5369** SEARCH FOR $\alpha$-INDUCED FISSION OF SILICON 28. N. O. Lassen and Gunnar Soerensen (Univ. of Copenhagen). Nucl. Phys., 38: 450-2(Nov. 1962). (In English)

An ionization chamber was filled with $SiH_4$. The cross section for the reaction $Si^{28}(\alpha,O^{16})O^{16}$ for 19.5-Mev $\alpha$ particles was found to be smaller than 0.005 mb/sr for $\theta_{CM} \approx$ 90°. The method for making the silane was described. (auth)

**5370** SOME THEORETICAL ASPECTS OF THE ANOMALOUS SHAPE IN THE ALLOWED BETA DECAY SPECTRA. B. Eman and D. Tadic (Institute "Rudjer Boskovic," Zagreb). Nucl. Phys., 38: 453-65(Nov. 1962). (In English)

The influence of strong interactions (nuclear forces) on weak interactions is investigated in the case of nuclear beta decay. The aim is to see whether in the allowed transitions such influences can produce an anomalous distortion of the form 1 + b/W. The V-A combination of interaction is chosen. The general form of the non-relativistic interaction Hamiltonian including relativistic effects is taken into account. Correction factors for the spectra and longitudinal polarization are given. The case of the G-non-conserving term is discussed separately. It seems that the anomalous distortion (if it really exists) cannot result from the influence of strong interactions. It is easy to produce distortion of the desired form for either $\beta^+$ of $\beta^-$ decay separately, but it is impossible to do this for $\beta^+$ and $\beta^-$ decays simultaneously. (auth)

**5371** INTERNAL CONVERSION STUDIES IN THE $I^{132}$ DECAY. D. Willard, J. H. Hamilton, and R. G. Albridge (Vanderbilt Univ., Nashville). Nucl. Phys., 38: 466-77(Nov. 1962). (In English)

The electron spectrum in the energy range of 575 to 675 kev from the decay of $I^{132}$ is studied by means of an iron-free spectrometer. Internal conversion lines corresponding to transitions of 522 ± 1, 630.4 ± 0.7, 672 ± 2, 667.7 ± 0.5, and 652 ± 4 (tentatively established) kev are recorded. The K-conversion coefficient of the 668-kev transition is measured by the internal-external method to be $(3.3 \pm 0.9) \times 10^{-3}$. This value agrees, within the large limits of error, with the theoretical E2 conversion coefficient value. (auth)

**5372** ANGULAR CORRELATIONS FOR THE $C^{13}(He^3,\alpha\gamma)C^{12}$ REACTION. H. D. Holmgren and E. A. Wolicki (Naval Research Lab., Washington, D. C.). Nucl. Phys., 38: 489-503(Nov. 1962). (In English)

The angular correlations between the first-excited-state alpha particles from the $C^{13}(He^3,\alpha)C^{12}$ reaction and the subsequent 4.43-Mev gamma rays are studied as functions of the angle of emission of the gamma rays, for alpha particles emitted at laboratory angles of 10, 25, 40, 90, and 128° at a bombarding energy of 4.50 Mev. The correlation functions are fitted with an expression of the form $W(\theta_\gamma) = 1 + b_2 \cos 2(\theta_\gamma - \theta_2) + b_4 \cos 4(\theta_\gamma - \theta_4)$. The cos $4\theta$ term dominates the correlation function at low angles and the $\theta_4$ phase angle remains constant, while the $\theta_2$ phase angle behaves similar to the recoil axis at low angles. The behavior of the cos $4\theta$ term is inconsistent with a pickup model for the reaction. Other possible direct-exchange interaction models are discussed. (auth)

**5373** A NOTE ON THE MEASUREMENT OF THE $U^{238}$ CADMIUM RATIO. Biagio Arcipiani, Delfina Ricabarra, and Guillermo H. Ricabarra (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 14: 316-17(Nov. 1962). (BNL-6054)

A technique for measuring the $U^{238}$ cadmium ratio in which a light water moderated lattice with 1.15% $U^{235}$ enriched metal rods and a 3 : 1 $H_2O$/U volume ratio was used. A noticeable increase of the cadmium ratio was found when the activities of the two foils were homogenized before counting. (W.D.M.)

**5374** $\alpha$-PARTICLE MODEL OF $^{20}$Ne AND $^{24}$Mg. M. Bouten (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Nuovo cimento (10), 26: 63-72(Oct. 1, 1962). (In English)

The $\alpha$-particle model has been applied to the $Ne^{20}$ and $Mg^{24}$ nuclei taking as equilibrium structures a trigonal and tetragonal bipyramid, respectively. The model easily reproduces four of the five low-lying rotational bands in $Ne^{20}$, and all low-energy levels with known spin and parity in $Mg^{24}$ are found in the theoretical spectrum. However, because of the many vibrational degrees of freedom and the small symmetry groups, there are so many rotational bands and undetermined parameters that the fits become much less significant. More new experimental levels are needed to test the $\alpha$-particle predictions. (auth)

**5375** ON THE SPIN-ORBIT DISTORTION IN DEUTERON STRIPPING REACTIONS. R. Cirelli and P. Gulmanelli (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo cimento (10), 26: 194-5 (Oct. 1, 1962). (In English)

In order to explain polarization effects in stripping reactions in the framework of the direct reaction model with distorted waves, spin-orbit interaction terms must be introduced. The deuteron spin-orbit distortion is treated without introducing new phenomenological potentials and an attempt is made to obtain it as an effect of the spin interaction of the individual nucleons. An expression is given for the stripping amplitude which is valid to the first order in the spin-orbit nucleon potentials. (W.D.M.)

**5376** ON THE POSSIBLE EXISTENCE OF A $0^+$ FIRST EXCITED STATE IN $^{26}$Mg. M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Nuovo cimento (10), 26: 202 (Oct. 1, 1962). (In English)

Recent experiments have pointed to the existence of a first excited state in $Mg^{26}$ at 1.33 ± 0.02 Mev, contrary to earlier results, which have indicated that the first excited state occurs at 1.84 Mev. A search for a $\gamma$ transition between the 1.84 Mev level and a possible 1.33 Mev by looking for coincidences between annihilation radiation and a 0.51 Mev gamma is described. (W.D.M.)

**5377** SEARCH FOR NEUTRINOLESS COHERENT NUCLEAR CAPTURE OF $\mu^-$-MESONS. G. Conforto, M. Conversi, L. Di Lella, G. Penso, C. Rubbia, and M. Toller (Università, Rome; INFN, Rome; and CERN, Geneva). Nuovo cimento (10), 26: 261-82(Oct. 16, 1962). (In English)

A high sensitivity experiment to search for the neutrinoless conversion of a muon into an electron ($\mu^- + N = N + e^-$, where N is a Cu nucleus) has been carried out at the CERN Synchrocyclotron. The space correlation between the muon and the electron was seen in a spark chamber operated as a target in the muon beam. The time correlation was observed on an oscilloscope trace which also contained the pulse from a large NaI(Tl) crystal, used to measure the energy of the electron (103.8 Mev in the case of the above mentioned process occurring coherently in the Cu plates of the chamber). Nearly 2.4 billion $\mu^-$-mesons were stopped during the main run. From the scanning of the film of the chamber (two 90° stereo-views) and of the corresponding oscilloscope pictures obtained in this run, four events were found fulfilling all requirements of time correlation, space correlation, and correct energy release in the NaI counter. It is shown, however, that ~5 ± 2 is the expected number of events of spurious nature. Hence, if the neutrinoless coherent nuclear capture of a meson exists at all, its branching ratio to the ordinary capture is concluded to be less than $2.2 \times 10^{-7}$ with 90% confidence level. This negative result fits into the recent discovery of two kinds of neutrinos. (auth)

**5378** EXCITED LEVELS IN $^{57}$Co FROM THE DECAY OF $^{57}$Ni. G. Chilosi, S. Monaro, and R. A. Ricci (Istituto Nazionale di Fisica Nucleare, Naples and Università, Naples). Nuovo cimento (10), 26: 440-60(Nov. 1, 1962). (In English)

The decay of $Ni^{57}$ has been the subject of an extensive investigation in order to obtain detailed information about the level structure of the odd-even $Co^{57}$. Scintillation techniques have been used; particular attention has been devoted to possible $\gamma$-$\gamma$ cascades, which were investigated by summing techniques (well-type crystal and Hoogenboom spectrometers) in addition to the normal coincidence methods. Two new levels at 1750 and 1590 kev have been established with direct de-excitation to the $Co^{57}$ ground-state, in addition to the already known levels at 1890, 1490, and 1360 kev. It has been confirmed that the 1490-kev level is the only one which decays by a cascade of $\gamma$ rays. The decay scheme of $Ni^{57}$ is reviewed on the basis of the experimental results, and the level structure of $Co^{57}$ is discussed from the point of view of the center of gravity theorem in nuclear spectroscopy. It is found that the situation for $Co^{57}$ is quite different from that of $Co^{58}$, for which the theorem has been reported to be applicable. Some details about the experimental investigation of possible $\gamma$-$\gamma$ cascades are discussed. (auth)

**5379** QUASI-ELASTIC SCATTERING OF PROTON BY p-PROTONS OF $^6$Li. Y. Sakamoto (Kyoto Univ.). Nuovo cimento (10), 26: 461-71(Nov. 1, 1962). (In English)

Quasi-elastic scattering of protons by the p-proton of $Li^6$ is calculated by using the direct interaction model. A wave function for the p-proton which contains more low-momentum components is favorable to explain the experimental data. (auth)

**5380** ON THE CONSTRUCTION OF LOW-ENERGY NUCLEAR POTENTIALS. F. Morey (Comisión Nacional de Energía Atómica, Bariloche, Argentina). Nuovo cimento (10), 26: 525-36(Nov. 1, 1962). (In English)

It is shown that the potentials that can be defined for the nucleon-nucleon problem from the theory of double dispersion relations cannot be constructed by a generalization of the method of Charap and Fubini. An explicit expression for the identification of the potentials in the nonrelativistic limit in configuration space is presented. (auth)

**5381** SPURIOUS STATE IN CONNECTING WITH $\beta$-VIBRATION OF NUCLEI. D. Bès (Universitad Buenos Aires) and Z. Szymański. Nuovo Cimento (10), 26: 787-9(Nov. 16, 1962). (In English)

An equation for the frequency of the quadrupole axially symmetric oscillations ($\gamma$ vibrations) of the atomic nucleus is derived. The derivation includes pairing interaction between nucleons. The equation contains one solution, which corresponds to the spurious zero-frequency state, which is a mixture of the ground states of the neighboring nuclei. (auth)

**5382** ANALYSIS OF THE INELASTIC SCATTERING OF ALPHA PARTICLES. [PART] I. R. H. Bassel (Oak Ridge National Lab., Tenn.), G. R. Satchler, R. M. Drisko, and E. Rost. Phys. Rev., 128: 2693-2707(Dec. 15, 1962).

The inelastic scattering of medium-energy alpha particles is interpreted as a direct interaction, using the distorted-waves theory. A deformed potential-well interaction based on the collective model of the nucleus is found to give results in good agreement with experiment. The parameters of the potential well are determined by fitting the elastic scattering, and the multipole deformations obtained from the magnitudes of the inelastic cross sections agree reasonably well with those obtained by other techniques. The effects on the theoretical predictions of variations in the parameters are described. Some preliminary study of the effects of including Coulomb excitation is also included. (auth)

**5383** ANALYSIS OF THE INELASTIC SCATTERING OF ALPHA PARTICLES. [PART] II. E. Rost (Univ. of Pittsburgh, Oak Ridge National Lab., Tenn., and Princeton Univ., N. J.). Phys. Rev., 128: 2708-16(Dec. 15, 1962). PUC-1962-74)

The analysis of the inelastic scattering of medium-energy alpha particles is continued using the distorted-waves theory. Attention is given to the qualitative features of these reactions; in particular, the characteristic oscillations in the angular distributions and the associated phase rule. The weak-coupling approximation is studied and is shown to be valid for most medium-energy ($\alpha,\alpha'$) reactions. The distorted-wave theory is compared with alternative theories of inelastic scattering and also with a preliminary sample of experimental data. (auth)

**5384** EFFECT OF THE NUCLEAR ELECTRIC FIELD ON THE ELASTIC SCATTERING OF DEUTERONS. C. F. Clement (Atomic Energy Research Establishment, Harwell, Berks, Eng. and Princeton Univ., N. J.). Phys. Rev., 128: 2728-38(Dec. 15, 1962). (PUC-1962-80)

The asymmetric action of the nuclear electric field on the deuteron is found to strongly affect the elastic scattering cross section on medium and heavy nuclei. Expressions for the scattering amplitude are found in the first and second Born approximations and in the adiabatic approximation. In the latter case the expression is evaluated and compared with experiment, giving rough agreement in magnitude, but not in shape, with deviations from Rutherford scattering found at low energies on medium and heavy nuclei. The high-energy plane-wave limit of the second Born approximation amplitude is evaluated. It is peaked in the forward direction, is large in magnitude for heavy nuclei, and decreases with increase in energy. Consequences for deuteron optical models are discussed. (auth)

**5385** REACTION $V^{51}$(n,d)$Ti^{50}$ AT 14.4 Mev. K. Ilakovac (Inst. Ruder Bošković, Zagreb), L. G. Kuo, M. Petravić, I. Šlaus, P. Tomaš, and G. R. Satchler. Phys. Rev., 128: 2739-44(Dec. 15, 1962).

Measurements have been made of the differential cross sections for the $V^{51}$(n,d) reaction at 14.4 Mev, exciting the $0^+$, $2^+$, $4^+$, and $6^+$ states in $Ti^{50}$. A distorted-wave Born approximation (DWBA) analysis of the results shows them to be consistent with the predictions of the simple shell model, that is, pure $(f_{7/2})^3$ configuration for $V^{51}$ ground state, with seniority a good quantum number, within the uncertainties of both the experiment and the analysis. In particular, the data are consistent with pure $l = 3$ transitions, although small amounts of $l = 1$ pickup to the $2^+$ and $4^+$ states cannot be excluded. The uncertainties in the DWBA analysis, and their effects on quantitative determination of the spectroscopic factors, are fully discussed. (auth)

**5386** MEAN LIFETIMES OF THE FIRST EXCITED STATES OF $Li^7$ AND $Na^{23}$ BY RESONANCE SCATTERING OF BREMSSTRAHLUNG. W. L. Mouton, J. P. F. Sellschop, and R. J. Keddy (Univ. of Witwatersrand, Johannesburg). Phys. Rev., 128: 2745-8(Dec. 15, 1962).

A 1.4-Mev electron accelerator was used as a source of bremsstrahlung to determine the widths $\Gamma$, and, hence, the mean lifetimes $\tau$, of the first excited states of $Li^7$ and $Na^{23}$. Self-absorption experiments were performed in both cases. For the 480-Kev level in $Li^7$ the following results were obtained: $\Gamma = (5.28 \pm 0.27) \times 10^{-3}$ ev, corresponding to $\tau = (1.25 \pm 0.06) \times 10^{-13}$ sec. For the 440-kev level in $Na^{23}$ the results obtained were $\Gamma = (3.66 \pm 0.50) \times 10^{-4}$ ev, corresponding to $\tau = (1.80 \pm 0.28) \times 10^{-12}$ sec. (auth)

**5387** BETA SPECTRUM OF $Mn^{56}$. D. A. Howe, L. M. Langer, E. H. Spejewski, and D. E. Wortman (Indiana Univ., Bloomington). Phys. Rev., 128: 2748-50(Dec. 15, 1962).

A detailed magnetic spectrometer study of the beta spectrum of $Mn^{56}$ was made with particular emphasis on the shape of the highest energy group. In spite of the high comparative half-life for this 3+ to 2+ allowed transition, no evidence was found for any contribution to the shape factor from higher order terms. The beta spectrum consists of the following groups: 2.838 Mev, 47%, log ft = 7.1; 1.028 Mev, 34%, log ft = 5.3; 0.718 Mev, 18%, log ft = 5.5; 0.30, ≈1.%, log ft = 5.3. (auth)

**5388** NUCLEAR EXCITATION BY 180° ELECTRON SCATTERING. R. D. Edge and G. A. Peterson (Stanford Univ., Calif.). Phys. Rev., 128: 2750-5(Dec. 15, 1962).

Magnetic multipole transitions in $Be^9$, $B^{10}$, $B^{11}$, $C^{12}$, $N^{14}$, $O^{16}$, and $Si^{28}$ were studied by measuring the energy spectra resulting from the scattering of 41.5-Mev primary electrons through an angle of 180°. At this angle of scattering, electric multipole transitions were greatly suppressed, and in addition, the background radiation tail accompanying the elastic peak was minimized. Inelastic electron scattering cross sections were obtained by comparing the inelastic peaks to the electron-proton elastic scattering peak and radiation widths were deduced by using virtual photon theory. Inelastic scattering peaks corresponding to excitation energies of 2.4 and 14.7 Mev were measured for $Be^9$; 7.9, 11.8, and 14.0 Mev for $B^{10}$; 2.1, 4.4, 4.9, 7.3, 9.1, 10.4, and 12.9 Mev for $B^{11}$; 15.1 Mev for $C^{12}$; 9.2 and 10.5 Mev for $N^{14}$; and 11.6 Mev for $Si^{28}$. No excitations were observed for $O^{16}$ below 15 Mev, and no excitations were observed in $Ca^{40}$ below the giant resonance for 160° electron scattering. (auth)

**5389** POLARIZATION OF HIGH-ENERGY PHOTOPROTONS FROM LIGHT ELEMENTS. F. F. Liu, F. J. Loeffler, T. R. Palfrey, and Y. S. Kim (Purdue Univ., Lafayette, Ind.). Phys. Rev., 128: 2784-8(Dec. 15, 1962).

The polarizations of photoprotons from Li, Be, B, and C were measured by means of a counter polarimeter at proton production angles of 45°, 56°, and 90° in the laboratory system. The photon source was the bremsstrahlung from the Purdue synchrotron operating at a peak energy of 335 Mev. The observed protons had energies in the range 135 to 200 Mev. The left-right asymmetry of scattering of the photoprotons in a carbon analyzer was used to determine their polarization. The observed polarization was small and is consistent both with a zero value and with the theory. A qualitative discussion in terms of quasi-deuteron and isobar models is given. (auth)

**5390** NUCLEAR MAGNETIC DIPOLE MOMENT OF $Ca^{41}$. E. Brun (Univ. of Colorado, Boulder), J. J. Kraushaar, W. L. Pierce, and Wm. J. Veigele. Phys. Rev. Letters, 9: 166-7(Aug. 15, 1962).

The nuclear magnetic dipole spin resonance of $Ca^{41}$ in a saturated $Ca(NO_3)_2$ aqueous solution was observed. A description is given of the experimental equipment and procedure. The amplitude of the $Ca^{41}$ nuclear induction signal indicates a spin quantum number of $^7/_2$. The corrected nuclear magnetic dipole moment is found to be −1.5946 nm. Various other predictions of the $Ca^{41}$ resonance are discussed. (H.D.R.)

**5391** EXPERIMENTAL STUDY OF THE ($He^3$,t) REACTION. A. G. Blair and H. E. Wegner (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 9: 168-9 (Aug. 15, 1962).

The ($He^3$,t) reaction was studied on several medium-weight nuclei ($50 \lesssim A \lesssim 100$) and on the lightweight nonmirror nucleus, $Mg^{26}$. Triton energy spectra from the ($He^3$,t) reaction on $Fe^{56}$, $Ti^{48}$, and $Mg^{26}$ are plotted and discussed. Angular distributions of tritons from $Fe^{56}(He^3,t)Co^{56}$, $Mg^{26}(He^3,t)Al^{26}$, $Mg^{25}(He^3,t)Al^{25}$, and $Al^{27}(He^3,t)Si^{27}$ ground-state reactions are shown and compared. (H.D.R.)

**5392** ON THE DECAY OF $^{153}$Gd. L. Blok, W. Goedbloed, E. Mastenbroek, and J. Blok (Vrije Universiteit, Amsterdam). Physica, 28: 993-1006(Oct. 1962). (In English)

The electron capture decay of $Gd^{153}$ (236d) has been studied with NaI scintillators and various proportional counters. Intensities of the gamma and K-X radiation of 42, 70, 97, and 103 kev de-exciting the levels at 97, 103, and 173 kev in $Eu^{153}$ are given. The total transition energy was found to be 242 ± 3 kev with the help of a measurement of the K-capture fractions by the coincidence method. Intensities of the electron capture branches were obtained. (auth)

**5393** SCATTERING OF 14 Mev NEUTRONS FROM MOLYBDENUM. M. K. Machwe (Univ. of Delhi). Physica, 28: 1011-14(Oct. 1962). (In English)

The differential cross section for the elastic scattering of 14-Mev neutrons from molybdenum has been measured in a ring geometry using a plastic scintillator as detector. The measurements are taken over an angular range between 10 and 138°. The results are compared with the optical model calculations of Bjorklund and Fernbach. Using two different detector thresholds, the differential cross section for the inelastic scattering of neutrons of energies from 9.6 Mev to 12.2 Mev is also obtained. (auth)

**5394** THE HALF-LIFE OF THE 152 kev TRANSITION IN $^{182}$W. E. Bashandy and M. S. El-Nesr (Uppsala Univ.). Physica, 28: 1015-18(Oct. 1962). (In English)

The half life of the 152-kev transition in $W^{182}$ has been measured by delayed electron-electron coincidence technique. A value of $T_{1/2} = (2.25 \pm 0.08) \times 10^{-9}$ sec was obtained. It was found that the 152-kev El transition is retarded by a factor $1.13 \times 10^{5}$ compared with the single-particle lifetime prediction. (auth)

**5395** THE RUTHERFORD MEMORIAL LECTURE 1962. SOME INTERRELATIONS OF NUCLEAR STRUCTURE WITH ELEMENTARY PARTICLE PHYSICS. D. H. Wilkinson (Nuclear Physics Lab., Oxford). Proc. Phys. Soc. (London), 80: 997-1040(Nov. 1, 1962).

This lecture is a study of some ways in which elementary-particle physics and nuclear-structure physics can complement each other. Each field can aid progress and understanding in the other, and knowledge from one field can be used as a technique for carrying out research in the other. (auth)

**5396** ANALYSIS OF ($^{3}$He,p) AND ($\alpha$,n) REACTIONS. M. El Nadi and H. Sherif (Atomic Energy Establishment, Cairo). Proc. Phys. Soc. (London), 80: 1041-56(Nov. 1, 1962).

Theoretical expressions are derived for ($He^{3}$,p) and ($\alpha$,n) reactions, on the assumption that the reaction proceeds as a stripping process for both the projectile and the target nucleus. The resulting theoretical formulas are compared with some experimental data. Satisfactory agreement is observed. (auth)

**5397** ON THE ORIGIN OF HEAVY PARTICLE STRIPPING. D. Robson (Univ. of Melbourne). Proc. Phys. Soc. (London), 80: 1067-72(Nov. 1, 1962).

The formal theory of rearrangement collisions is investigated using correctly symmetrized wave functions. The resulting expression for the scattering amplitude is discussed using a generalized distorted-wave approximation. It is shown that the exchange amplitude known as heavy-particle stripping does not arise from a matrix element of the form discussed recently by Day et al. The possibility of a non-vanishing amplitude for heavy-particle stripping in the case of an infinitely massive target is briefly discussed. (auth)

**5398** THE RADIAL VARIATION OF THE ABSORBING PART OF THE NUCLEAR OPTICAL POTENTIAL. P. E. Hodgson (Dept. of Nuclear Physics, Oxford). Proc. Phys. Soc. (London), 80: 1161-70(Nov. 1, 1962).

The methods used to determine the shape of the imaginary (or absorbing) part of the nuclear optical potential by phenomenological analyses of the experimental data on nucleon-nucleus elastic scattering are critically examined. A detailed analysis is made of the data on the elastic scattering of 7.5 and 9.75 Mev protons by copper, and it is found that the radius of the absorbing part of the potential is about one fermi greater than that of the real part. All the low-energy data reviewed are consistent with this, and with the theoretical calculations of the absorbing potential. Phenomenological optical model analyses are insensitive to the absorption in the nuclear interior, and at present are not sufficiently accurate to determine it. (auth)

**5399** MANY-BODY THEORETICAL APPROACH TO THE FIRE-BALL MODEL IN MULTIPLE PRODUCTION OF PARTICLES. Osamu Kamei (Ochanomizu Univ., Tokyo), Tetsuro Kobayashi, and Mikio Namiki. Progr. Theoret. Phys. (Kyoto), 28: 233-50(Aug. 1962). (In English)

The fire-ball observed in the multiple production of particles is interpreted and analysed in terms of a correlated assembly of produced particles like a superfluid. It is shown that the momentum spectrum of produced mesons is proportional to the form of $dk/k^{2}$, by assuming $\lambda\phi^{4}$ for the meson-meson interaction Hamiltonian in the final state. A possibility of the many fire-balls is briefly discussed. Before going into these discussions a possible reduction of the S-matrix element or the cross section of the overall process is presented, where its final-state interaction part may be separated from the high energy interaction part in a short collision time. (auth)

**5400** THEORY OF VECTOR INTERACTIONS IN NUCLEAR BETA DECAY. Jun-Ichi Fujita (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 28: 338-46(Aug. 1962). (In English)

In a previous work the Siegert theorem was extended to vector interactions in nuclear beta decays on the basis of the conserved vector current hypothesis. It was shown that the experimental data of RaE are consistent with the conserved vector current hypothesis. The purpose of this note is to give the general formulae for arbitrary order of forbidden transitions, since it is highly desirable to investigate as many other non-unique forbidden beta decays as possible. The validity of non-relativistic approximation is assumed for the motion of nucleons in nuclei, so that the formalism is completely analogous to the conventional theory of nuclear radiative transitions. (auth)

**5401** FERMI SURFACES AND SPIN STRUCTURES IN HEAVY RARE-EARTH METALS. Kei Yosida and Atsuko Watabe (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 28: 361-70(Aug. 1962). (In English)

The screw-like spin structures in heavy rare earth metals found by neutron diffraction experiments are investigated on the basis of the s-$f$ exchange model. The calculation shows that a screw structure with the screw axis along the c axis is stable for a hcp lattice with three conduction electrons per atom and that the period of the screw becomes longer with decrease of the atomic number. From this and other considerations it is concluded that the spin structure has a close correlation with the Fermi surface for heavy rare earth metals. (auth)

**5402** NUCLEAR MAGNETIC RELAXATION NEAR THE CURIE TEMPERATURE. Tôru Moriya (Tokyo Univ.), Progr. Theoret. Phys. (Kyoto), 28: 371-400(Aug. 1962). (In English)

A theoretical study is made on the nuclear spin relaxation in magnetic crystals near their Curie temperatures. The exchange narrowed hyperfine broadening of the NMR line width is shown to increase due to the slowing down of a certain part of the electron spin fluctuations as the transition point is approached, giving rise to the line width whose asymptotic value near the transition point is proportional to $[T_C/(T - T_C)]^{1/2}$ in cubic ferromagnets and to $[T_N/(T - T_N)]^{1/2}$ in cubic antiferromagnets. The spin-lattice relaxation rate is dominated by this mechanism and has the same value as the above contribution to the line width. The effect of the anisotropy and the external magnetic field on this mechanism is also discussed. The indirect nuclear spin interaction via the hyperfine interaction is treated from a general point of view by using the wavelength dependent susceptibility. The susceptibility is calculated with the use of a molecular field approximation. Since the spatial correlation between the spins becomes long ranged as the transition point is approached, the indirect nuclear spin interaction becomes long ranged at the same time. In non-cubic crystals this interaction gives rise to the line width whose asymptotic value near the transition point (both above and below $T_C$) is proportional to $[T_C/|T - T_C|]^{1/2}$ both in ferro- and antiferromagnets and the coefficient of this temperature factor is of the same order of magnitude as those in the first mechanism. In cubic crystals this effect vanishes or is reduced by orders of magnitude. The theory is compared with the $F^{19}$-resonance experiments in $MnF_2$ and the agreement is not unreasonable. (auth)

**5403** ON ATOMIC BEAMS. R. A. Marrus and W. A. Nierenberg (Univ. of California, Berkeley). Rend. Scuola Intern. Fis. "Enrico Fermi," 17: 118-56([1962]).

Atomic beams are valuable for studying the nuclear properties of rare earths. A review is presented of the measurements made so far on the rare earth and actinide isotopes by atomic beams. The theory and techniques of atomic beam measurements are discussed. (D.L.C.)

**5404** THE NUCLEAR RESONANCE FLUORESCENCE OF GAMMA RADIATION AND MÖSSBAUER EFFECT. E. Schopper (Universität, Frankfurt am Main). Umschau Wiss. Tech., 62: 553-7(Sept. 15, 1962). (In German)

The physical bases for nuclear resonance absorption are described, and the Mössbauer experiment is discussed. The significance of the Mössbauer effect and its direct experimental detection are reviewed. The physical application of the Mössbauer effect was indicated. (J.S.R.)

**5405** AN INVESTIGATION OF TWO QUANTUM TRANSITIONS OF NUCLEI. M. A. Listengarten. Vestnik Leningr. Univ., No. 16, Ser. Fiz. i Khim., No. 3, 142-3 (1962). (In Russian)

The probability of the internal Compton effect multiplied by the internal conversion coefficient was found to coincide with the probability of double conversion, which was determined experimentally. Some conclusions about the probable Feynmann graphs, which describe the process, were made. (auth)

**5406** HYPERFINE STRUCTURE SPLITTING OF RECOIL-FREE GAMMA LINES. V. TEMPERATURE DEPENDENCE OF THE HYPERFINE STRUCTURE SPLITTING OF THE 8.42-kev STATE IN $Tm^{169}$ IN THE TEMPERATURE REGION BETWEEN 300°K AND 14°K. M. Kalvius, W. Wiedemann, R. Koch, P. Kienle, and H. Eicher (Technische Hochschule, Munich). Z. Physik, 170: 267-73(1962). (In German)

The temperature dependence of the hyperfine splitting of the 8.42 kev $\gamma$ ray of $Tm^{169}$ in oxide crystals was investigated using the Mössbauer-effect. The quadrupole splitting of the first excited state in $Tm^{169}$ showed a pronounced increase with decreasing temperature. This manifests a contribution of various Stark levels, which are occupied according to their Boltzmann factors, to an average field gradient at the nucleus. It is shown in a model calculation for the temperature dependence of the field gradient that the data can be explained using a maximum splitting of about 400 $cm^{-1}$ of the electronic groundstate by the crystal field. The emission pattern of the $Er_2O_3$-source is broadened below 20°K. This is possibly produced by an interaction with a residual magnetic field from the surrounding Er-ions. (auth)

**5407** MEASUREMENT OF THE CHAIN LENGTHS FOR THE $\beta$ DECAY OF FISSION PRODUCTS FROM THE THERMAL FISSION OF $U^{235}$. P. Armbruster and H. Meister (Technische Hochschule, Munich). Z. Physik, 170: 274-302 (1962). (In German)

The various masses of fission products from $U^{235}$ thermal fission were spacially separated by a helium filled magnetic mass separator. The number and energy of the $\beta$ decays to the stable nuclides were counted and measured by a scintillation spectrometer. The time dependence of the $\beta$ activity and $\beta$ energy of the total of the $U^{235}$ fission products was measured. The number of $\beta$ decays/fission was found to be $(6.9 \pm 0.4)$ $\beta$ particles fission, the energy liberated by $\beta$ decays $(8.1 \pm 0.4)$ Mev/fission. A calculation of the total $\beta$ decay energy is given and compared with experimental data. The chain lengths of $\beta$-decay chains as a function of mass of the fission products were measured. Data on prompt neutron emission from fission products combined with the chainlength measurement give the mass dependence of the most probable charge of the primarily formed fission products. A recent model of asymmetric fission is shown to agree with the experimental data. The data give strong evidence that the filled nucleon shells of $Z = 50$ and $N = 50$ are responsible for the asymmetric fission mechanism. (auth)

**5408** DELAYED COINCIDENCE MEASUREMENT OF THE LIFETIME OF THE 129-kev LEVEL IN Ir 191. J. Lindskog, T. Sundstroem, and P. Sparrman (Univ. of Uppsala). Z. Physik, 170: 347-54(1962). (In English)

The lifetime of the 129-kev level in $Ir^{191}$ was measured by the delayed coincidence technique. The half-life was found to be $(13.1 \pm 1.0) \times 10^{-11}$ seconds. This value is compared with the result of the measurements of the level width by Mössbauer experiments. The properties of the two first excited states in $Ir^{191}$ and $Ir^{193}$ are discussed. (auth)

**5409** THE TOTAL CAPTURE PROBABILITY OF MUONS BY $C^{12}$. Marian Ruel. Thesis, Washington, D. C., Catholic Univ. of America, 1962. 38p.

The total capture probability of negative muons by the $C^{12}$ nucleus was calculated as a sum of partial transition rates to the individual levels of $B^{12}$. The general formalism for calculating the transition rate between two definite nuclear states was used. The theory for muon capture was basically the same as that used in beta decay calculations. Upon comparison of the theoretical predictions with the results of experimental measurements for the beta decay of $B^{12}$, it was found that the results of theory were too large by a factor of 4.8 when a shell model of the nucleus was used. The assumption made is that the nuclear matrix elements describing muon capture by $C^{12}$ are in error by the same factor. A shell model of the nucleus was used in order that the wave function of each boron level may be given the correct spin and parity. This has the advantage that the forbiddenness of each transition is accounted for. The eight-particle configuration rendered a consideration of the mixing of states implausible, so that an extreme single-particle model was used. It was assumed that jj-coupling is a reasonable approximation. Where the spin and parity assignments of a particular $B^{12}$ level remain doubtful, calculations were made to place upper and lower limits upon the transition rate to this level. By writing a general wave function which represents any one of the final states, the nuclear matrix elements may be reduced to simplified form and numerical values obtained simply by substitution of the quantum numbers of the level under consideration. According to the calculation, captures to the 0.95 Mev level of $B^{12}$ should be between 0.5 and 0.8% of all bound state captures. Predictions regarding the 1.67 Mev level were in poor agreement with experiment, the lower limit to the calculated value being too large by a factor of 2.3. It is possible that the spin and parity assignments currently accepted for this level are in error, but a more accurate estimation of the error in the nuclear matrix elements should be made before a correction is suggested. If the captures to the 2.62 and 2.72 Mev levels are considered to be second forbidden, then the predictions are in good agreement with experimental data available. (Dissertation Abstr., 23: No. 4, 1962)

**5410** PHOTOPROTON REACTION IN BERYLLIUM-9. Franklyn Miles Clikeman. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1962. 89p.

The yield for the Be$^9$(γ,p)Li$^8$ reaction was measured from the threshold (16.89 Mev) up to 57 Mev using a bremsstrahlung beam. Data were taken in energy steps of 0.046 Mev for the first several Mev and in energy steps of 0.94 Mev for the remainder of the yield curve. The yield curves were analyzed for the cross section. Several small resonances in the cross section that correspond to known energy levels in the Be$^9$ nucleus were observed near the threshold. The giant resonance cross section reached a peak value of 2.64 ± 0.33 mb at an energy of 23 Mev and possessed a large high energy tail. The integrated cross section to 56.8 Mev was 41.4 ± 4.6 Mev-mb. (Dissertation Abstr., 23: No. 4, 1962)

**5411** CLSQ, THE BROOKHAVEN DECAY CURVE ANALYSIS PROGRAM. J. B. Cumming (Brookhaven National Lab., Upton, N. Y.). 18p. BNL-6470

To be published in NAS-NS-3107, Proceedings of the Symposium on Applications of Computers to Nuclear and Radiochemistry, held in Gatlinburg, Tenn., Oct. 18-19, 1962.

A program for the analysis of multicomponent decay curves by a least-squares procedure was coded for an IBM-7090 computer. The FORTRAN language was used for the main calculation and FAP for some of the subroutines. Provision for determining half lives of the nuclear species is provided by an iterative routine starting from a set of trial values. The mathematical method is outlined. Input data and a typical output are shown. (M.C.G.)

## Particle Accelerators

**5412** (NDL-TM-6) CALIBRATION OF THE T(d,n)He$^4$ YIELD FROM THE NUCLEAR DEFENSE LABORATORY'S POSITIVE ION ACCELERATOR. David Thomas and John C. Goshorn, Jr. (Army Chemical Corps Nuclear Defense Lab., Army Chemical Center, Md.). July 1962. 5p.

The Cockcroft-Walton Positive Ion Accelerator, installed at U. S. Army Nuclear Defense Laboratory, Army Chemical Center, Maryland with a maximum energy of 780 kev, is capable of producing neutron or gamma reactions, or of providing a direct beam of approximately one milliampere of low Z nuclei. The T(d,n)He$^4$ reaction which produces 14-Mev neutrons and 3.5-Mev alpha particles is considered. Two methods were used to measure the neutron flux at a given point. The first method employed the use of a flux measuring device known as a long counter. The second method calculated the neutron flux at a given point from a knowledge of the total neutron production, their angular distribution, and the distance to the point of interest. This latter technique consisted of determining the D-T yield by the associated alpha method. It was concluded that the long counter is most useful as a monitor of neutron production. Its use as an absolute flux measurement device required the determination of efficiency at the given energy and background neutron count rate, I$_b$. The empirical efficiency expression may be used to obtain flux accuracies of about ±10%. For many experimental requirements, this is satisfactory. The alpha particles may be counted with high accuracy. The flux, however, must be calculated, and such a calculation involves assumptions. The errors involved become more important as deuteron energy increases. Counting alphas at 90° reduces the effect of target parameters on yield determination. For the best possible determination of numbers of neutrons, this configuration, along with low deuteron energy, should be utilized. (auth)

**5413** (ORNL-TM-423) A COLLIMATOR STUDY FOR A 5-Gev ELECTRON BEAM. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.). Dec. 7, 1962. Contract [W-7405-eng-26]. 23p.

A calculation to determine the effectiveness of collimators in a high-energy electron beam is described. Numerical results for a 5-Bev electron beam incident on a 135.42-cm-thick aluminum collimator with an inside radius of 0.85 cm are reported. (auth)

**5414** PROBLEMS IN TRIGGERING AND ADJUSTMENTS OF THE BETATRON OF THE INSTITUTE OF NUCLEAR PHYSICS (IAF). F. Ciorăscu, G. Baciu, M. Grecescu, S. Haltrich, C. Iliescu, and I. Leibovici (Inst. of Nuclear Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 105-21(1962). (In Rumanian)

The triggering and three-stage betatron operations are described. Electron induction, observations of the initial stages of acceleration, orbital equilibrium regulation, and electron trapping adjustments achieved by asimuthal corrections of phase heterogeneities and by magnet contraction are discussed. A special circuit compensating an equilibrium circuit shift at the end of the acceleration cycle was used in order to achieve maximum energy. (R.V.J.)

**5415** A 40 Mev ELECTRON ACCELERATOR FOR GERMANY. M. C. Crowley-Milling (AEI Research Lab., Manchester, Eng.). AEI (Assoc. Elec. Ind.) Eng., 2: No. 2, 63-9(Mar-Apr. 1962).

A linear accelerator for the injection of 40 Mev electrons into the 6 Bev machine of the Deutches Elektronen-Synchrotron is described. The accelerator was designed to place very close limits on the energy deviation and diameter and angular divergence of the electron beam to prevent oscillations from building up within the synchrotron. Descriptions are presented of the waveguide construction, electron-gun and pre-buncher, klystrons and drive systems, modulators, vacuum and water systems, and main controls. Performance data show the accelerator operates within the required limits. (H.D.R.)

**5416** THE FRASCATI ELECTRON SYNCHROTRON. M. Puglise and G. Sacerdoti (Comitato Nazionale Energia Nucleare, Rome). Alta Freq., 30: 755-66(1961). (RT/FI (62)10). (In Italian)

A rather detailed description of the Frascati electron-synchrotron is presented. The general principles are outlined, and the principal reasons for the actual construction are discussed. In describing the various plants, the greatest attention is devoted to the magnet and to the radiofrequency plant. A brief appendix of the theoretical consideration is added. The actual schemes and the photograph inserted give a general picture of this machine. (auth)

**5417** DEE VOLTAGE STABILIZER FOR THE INS VARIABLE ENERGY ORDINARY CYCLOTRON. Shigeki Suwa, Arata Suzuki, and Takanobu Yamada (Tokyo Univ.). Japan J. Appl. Phys., 1: 227-30(Oct. 1962). (In English)

A dee voltage stabilizer of grid control type was constructed for the INS variable energy ordinary cyclotron. With this stabilizer the dee voltage has been kept constant within 0.3% and the intensity modulation of the external beam has been practically eliminated. (auth)

**5418** A PULSER CIRCUIT FOR THE SYNCHRO-CYCLOTRON OSCILLATOR. Arata Suzuki and Takanobu Yamada (Tokyo Univ.). Japan J. Appl. Phys., 1: 231-3 (Oct. 1962). (In English)

A circuit was built for the oscillator of a synchrocyclotron, with which the oscillator can be stopped and started at a desired instant during the frequency modulation cycle. By reducing the duration of the oscillation to one fifth of the whole cycle the dee voltage was successfully raised during acceleration without increasing the mean ratio frequency power loss. In this way the beam intensity at the scattering chamber was increased by a factor of two, and a stable beam up to 0.3 $\mu$A was obtained within an area of 0.2 cm$^2$. (auth)

**5419** A METHOD OF MEASURING THE SPECTRUM OF ENERGY OF A HIGH ENERGETIC ION BEAM IN AN ACCELERATOR (CYCLOTRON, SYNCHROCYCLOTRON). W. Schwertfuehrer. Kerntechnik, 4: 447-8(Oct. 1962). (In German)

A method for measuring the spectrum of energy of a high energetic ion beam in an accelerator, based upon the coloration of alkali halide crystals by the impinging ion beam, is described. The length of the coloration zone is proportional to the maximum energy of the particles. The intensity of the coloration on different points of the crystal along the direction of movement of the ions was measured photometrically. A curve was plotted and by mathematical analysis the share of particular groups of energy of the coloration and thus the spectrum of energy was evaluated. The intensity of coloration was presumed to be proportional to the quantity of particles. (auth)

**5420** HIGH-VOLTAGE ACCELERATION TUBES UTILIZING INCLINED-FIELD PRINCIPLES. R. J. Van de Graaff, P. H. Rose, and A. B. Wittkower (High Voltage Engineering Corp., Burlington, Mass.). Nature, 195: 1292-3(Sept. 29, 1962).

The "total voltage effect," which limits the voltage across an evacuated tube in a manner distinct from that of ordinary insulation, generally prevents a linear increase in voltage with an increase in tube length for fixed voltage gradient along the tube. The performance of three large-aperture high-voltage tubes, which have been developed to avoid the total voltage effect, is described. (L.T.W.)

**5421** BETATRON POTENTIAL WELLS. A. B. Rubin (Williamson Development Co., Inc., West Concord, Mass.) and M. A. Levine. Nucl. Instr. Methods, 17: 75-7(Sept. 1962). (In English)

A new method of calculating betatron field parameters is described. Using a model betatron field, the effective radial potential well, orbit radius, and ratio of central field to orbit field are obtained. It is shown that potential wells of sufficient depth for electron injection into plasma betatrons can be achieved without difficulty. (auth)

**5422** GAS ENTRAINMENT RECOIL TARGET ASSEMBLY. A. M. Friedman and W. C. Mohr (Argonne National Lab., Ill.). Nucl. Instr. Methods, 17: 78-80(Sept. 1962). (TID-15318). (In English)

A new accelerator target assembly based on gas stopping and entrainment of recoiling reaction products is described. The target was found to be useful with beam densities up to 150 $\mu$a/cm$^2$. (auth)

**5423** STUDY OF ION SOURCE OF THE INVERSE MAGNETRON TYPE FOR CYCLOTRONS. D. Garreta, P. Benezech, and G. Knittner (C.E.N., Saclay, France). Nucl. Instr. Methods, 17: 123-4(Sept. 1962). (In French)

The cold-cathode ionization source was tried in order to ionize an atomic beam of very weak intensity. It has not yet been tested on the cyclotron, and its performances are now lower than those of the arc source (Morosov type). However, its efficiency and simplicity make it look promising. (auth)

**5424** ELECTRON MODEL STUDIES OF PARTICLE MOTIONS IN SPIRAL RIDGE MAGNETIC FIELDS. D. Orr (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Instr. Methods, 17: 151-6(Oct. 1962). (In English)

An electron model has been used to investigate both radial and vertical trajectories for one turn in a spiral ridge magnetic field. Extensive magnetic field measurements were made and a method of setting up reproducible magnetic fields taking into account remanent field and hysteresis effects was devised. Various plots of beam profile around the machine are discussed; in particular, the effects of harmonics of the magnetic field, higher than the fourth, on the radial betatron oscillation frequency, have been measured. (auth)

**5425** AN ELECTRON SPIN RESONANCE MAGNETOMETER-FOR TIME-VARYING FIELDS. J. L. Stahlke (Univ. of Illinois, Urbana). Nucl. Instr. Methods, 17: 157-60(Oct. 1962). (In English)

Equipment is described utilizing electron paramagnetic resonance for measuring the instantaneous value of the pulsed magnetic field of the University of Illinois 300 Mev Betatron in the range 3000 to 6400 gauss. The measurement of a time-varying field is reduced to the determination of a microwave frequency. An accuracy of 0.1% is achieved. (auth)

**5426** SYSTEM FOR ENERGY CONTROL AND ABSOLUTE CALIBRATION OF A 23-Mev BETATRON. K. N. Geller (Univ. of Pennsylvania, Philadelphia). Nucl. Instr. Methods, 17: 161-8(Oct. 1962). (In English)

The theoretical and technical features of a system used to determine and control the operating energy of a 23 Mev betatron are described. By observing the variation in orbit radius as a function of magnet excitation, we are able to predict the shape of the calibration curve to maximum operating energy. Although an absolute calibration of the predicted energy scale is possible, the present calibration is empirical and based on only the 16.22 Mev resonance in the $O^{16}(\gamma,n)O^{15}$ reaction. Photo-neutron threshold energies based on the present energy scale are in good agreement with accepted values. (auth)

**5427** REDUCTION IN TANDEM LOADING. Peter H. Rose (to High Voltage Engineering Corp.). U. S. Patent 3,067,347. "Application date Nov. 12, 1959."

An apparatus is described for the acceleration of charged particles. Tandem loading is reduced by providing magnetic fields in the vicinity of the high-voltage terminal that deflect low-energy charged particles so that they collide with some portion of the apparatus before they have acquired sufficient energy to cause the process to become regenerative. (R.J.S.)

**5428** STRUCTURE FOR LINEAR ION ACCELERATORS. Jacques Pottier (to Commissariat à l'Énergie Atomique). U. S. Patent 3,067,359. "Priority date May 5, 1958, France."

An apparatus is described for linearly accelerating ions that is comprised of a source for producing ionized particles, a structure for producing an accelerating electrical field capable of increasing the kinetic energy of the ionized particles, and a target to be bombarded. (R.J.S.)

## Plasma Physics and Thermonuclear Processes

**5429** (AD-275288) COLLECTIVE ASPECTS OF BREMSSTRAHLUNG EMISSION AND ELECTRICAL CON-

DUCTIVITY IN A PLASMA. Otto H. Theimer (New Mexico State Univ., University Park). Apr. 1962. Contract N9onr-953(07). 28p.

The bremsstrahlung spectrum and the a-c electrical conductivity of a plasma are calculated by classical methods, from a model in which the electrons interact with the plasma as a whole, and not with individual particles. The Fourier expansion of the particle density is employed for calculating the time dependent electrical field at the position of a moving electron, and the Fourier coefficients of the electrical field are used for calculating the bremsstrahlung emission and the conductivity. The method clearly exhibits the relation between these two quantities, and gives a rigorous expression for the cut-off parameter pmax as a function of the Debye shielding length, the electron mean free path, and the average particle separation. (auth)

**5430** (AD-276418) SOME ESTIMATIONS OF THE ELECTROMAGNETIC PARAMETERS FOR THE HYPERSONIC PLASMA SHEATH WITH A MAGNETIC FIELD. Richard J. Plugge (Ohio State Univ. Research Foundation. Antenna Lab., Columbus). May 15, 1962. Contract AF33 (616)-6782. 180p.

Constant index of refraction and extinction coefficient contours associated with the longitudinal propagation of left circularly polarized waves and the transverse propagation of extraordinary elliptically polarized waves in a lossy equilibrium plasma with a d-c magnetic field were plotted on rectangular coordinates representing vehicle height and velocity (h,v plane) for the stagnation point plasma of a hypersonic vehicle traveling in the atmosphere at seven typical telemetering frequencies with four magnetic field strengths. Some of the features of the curves and propagation characteristics in a magneto-plasma are discussed. The curves presented are similar to those for longitudinal propagation of right circularly polarized waves previously published. Also, curves of the (h,v) points of cutoff are shown. (auth)

**5431** (AFCRL-62-185) INTERACTION OF ELECTROMAGNETIC WAVES WITH A PLASMA. Final Report. Carson Flammer, S. V. Yadavalli, R. A. Nelson, and R. Blum (Stanford Research Inst., Menlo Park, Calif.). Apr. 1962. Contract AF 19(604)-7396. 146p. (AD-274758)

From statistical mechanical aspects of plasmas through relativistic and nonlinear treatments of plasmas, a study is presented of the plasma in the interface between the earth's magnetic field and the solar wind, and the coupling of electromagnetic energy into an inhomogeneous plasma. It is shown how appropriate initial distribution functions for a plasma are obtained from given initial macroscopic quantities by means of the maximum entropy principle. A new approach to the solution of the Liouville equation is also presented. Phenomenological considerations are used to obtain a one-particle distribution function that consists of two parts that account for the effects of the distant particles and the nearest neighbors. From this distribution function and Liouville's theorem, a general kinetic equation for a particle in a plasma and its dynamical friction are demonstrated. (auth)

**5432** (AWRE-0-14/62) A GUIDE TO THE RANGE OF ELECTRON DENSITIES IN TRANSIENT PLASMAS WHICH MAY BE MEASURED USING MICROWAVE AND OPTICAL INTERFEROMETERS. J. A. Russell (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Apr. 1962. 17p.

It is noted that in controlled fusion research, electron densities of $10^{12}$ to $10^{18}$/cm$^3$ are of interest. Microwave interferometers were used to measure electron densities up to $2.8 \times 10^{14}$/cm$^3$, and optical interferometers may be used to measure densities down to $10^{16}$/cm$^3$. Existing microwave interferometers may, in principle, be used to estimate electron densities at $10^{14}$ to $10^{16}$/cm$^3$ by superimposing a magnetic field on the plasma in the interferometer and employing the whistler mode of propagation through the plasma. (J.R.D.)

**5433** (D1-82-0150) EXTREMELY LOW FREQUENCY WAVES IN AN INHOMOGENEOUS HYDROMAGNETIC MEDIUM AND GEOMAGNETIC MICROPULSATIONS. Mathematical Note No. 248. William C. Hoffman (Boeing Scientific Research Labs., Seattle). Jan. 1962. 18p. (AD-273492)

A new type of wave motion is described which can exist in an inhomogeneous hydromagnetic medium at extremely low frequencies under certain conditions on the conductivity gradient of the medium. The basic hydromagnetic equations consist of Maxwell's equations, Ohm's law, an equation of motion for a non-viscous medium, and the equation of continuity. (auth)

**5434** (DCAS-TDR-62-12) ON THE STRUCTURE OF STRONG PLASMA SHOCK WAVES IN A TRANSVERSE MAGNETIC FIELD. G. G. Comisar (Aerospace Corp. Physical Research Lab., El Segundo, Calif.). Feb. 15, 1962. Contract AF04(647)-930. 24p. (AD-274693; TDR-930(2210-04)TR-2)

The structure of a plane stationary shock wave in a plasma with a transverse magnetic field is explored by using the restricted variational principle of Rosen to evaluate the adjustable factors of Mott-Smith's bimodal representation for the ion and electron distribution functions. The resulting solutions, in the strong shock limit, indicate that the particle number densities are essentially those of the nonmagnetic case, and that the transverse magnetic field departs considerably from the usual frozen-in field profile, resulting from the local dissipative effects of electrical conductivity. (auth)

**5435** (DCAS-TDR-62-45) EXPERIMENTAL MAGNETOHYDRODYNAMIC TURBULENCE INVESTIGATIONS. Semiannual Technical Report, July 1–December 31, 1961. E. B. Turner (Aerospace Corp. Physical Research Lab., El Segundo, Calif.). Feb. 28, 1962. Contract AF04(647)-930. 20p. (AD-274699; TDR-930(2210-03)TR-1)

An experimental program on magnetohydrodynamic turbulence is presented. The experimental apparatus, which is essentially a linear pinch device, is described. Experimental results which are discussed include electrical current waveforms, Kerr cell camera photographs, and magnetic field probe measurements. Kerr cell photographs clearly show the breakup of the plasma column as a result of instabilities; and a statistical study was begun of the sizes of the instabilities. A technique is described using an x-y oscilloscope to obtain an estimate of the correlation between two magnetic probe signals for various distances between the probes. From these data we hope to obtain the energy spectrum and an estimate of isotropy of the turbulence. (auth)

**5436** (DCAS-TDR-62-79) MODIFICATION OF THE ELECTRICAL PROPERTIES OF THE PLASMA SHEATH BY CONTAMINANT INJECTION. R. Betchov, A. E. Fuhs (Aerospace Corp. Physical Research Lab., El Segundo, Calif.); and R. M. Head (Naval Postgraduate School, Monterey, Calif.). Mar. 28, 1962. Contract AF04(647)-930. 24p. (AD-276098; TDR-930(2230-03)TN-6)

A method frequently proposed for modifying the electrical properties of the plasma sheath involves injection of various compounds into the gas stream. By introducing molecules of low ionization potential, the electron density should be enhanced. Injection of electronegative species may reduce the electrical conductivity. To test these ideas, an experimental program was conducted using an Ar plasma arc jet as a hot gas source. The relative changes of electrical conductivity of the gas mixture formed from the jet and ablation products were measured. The ablating materials were teflon and epoxy. Additional information was obtained by examining the radiation emitted from different gas stream locations in the wavelength interval 2436 to 5214 Å. A Baird 3-meter diffraction grating instrument was used. (auth)

**5437** (GGA-TR-62-8-A) STEADYSTATE ELECTRON DENSITIES FOR IRRADIATED PLASMAS. Quarterly Technical Note. J. I. F. King and R. Sillars (Geophysics Corp. of America, Bedford, Mass.). Mar. 1962. Contract AF 30(602)-2380. 26p. (RADC-TDR-62-106; AD-273973)

Steadystate electron density profiles were calculated for diffusion- and recombination-controlled plasmas irradiated by an external source of electromagnetic flux. In the first case the internal electron generation caused by progressive beam absorption is balanced by electron diffusion across the plasma boundaries. In the second model the beam-stimulated electron growth is limited by recombination. The efficiency of electron diffusion and consequent wall recombination as a heat transfer process is calculated and found never to exceed 30%. Furthermore, the nonlinear diffusion model gives rise to a stability criterion below which no steadystate electron configuration is possible. (auth)

**5438** (MATT-89) EQUILIBRIUM AND STABILITY FOR SYSTEMS WITH SMALL CURVATURE. John L. Johnson, John M. Greene, and Katherine E. Weimer (Princeton Univ., N. J. Plasma Physics Lab.). July 1961. Contract AT(30-1)-1238. 29p.

Expansion techniques were used to obtain analytic expressions for the stability criterion of toroidal hydromagnetic equilibria with $\ell = 2$ or $\ell = 3$ multipolar fields. The first case showed that care must be taken in using stability criteria in which the coupling of the Fourier modes of the perturbation is not correctly treated. The latter demonstrates the restrictions which the equilibrium criteria can impose on the system if the rotational transform vanishes somewhere in the system. (auth)

**5439** (PIBMRI-987-62) ELECTRON DENSITY PROFILE. Henry L. Bertoni (Brooklyn. Polytechnic Inst. Microwave Research Inst.). June 1962. Contract AF-19 (604)-8070. 29p. (AD-275512; AFCRL-62-421)

Methods are presented for finding the electron density profile of a plasma which varies in one dimension only. They are based on phase measurements of a microwave signal reflected from the plasma when the plasma frequency is greater than the signal frequency. The methods are applicable when the dimensions of the plasma are such that the WKB approximation to the wave solution is valid. This includes dimensions sufficiently small so as to make time of flight measurements, as used in ionospheric studies, difficult or impractical. Using one of these methods, the electron density distribution in a pulsed $H_2$ discharge between 6 × 8-in. electrodes placed 18 in. apart is found. (auth)

**5440** (TID-13633) ON THE NUMERICAL INVESTIGATION OF THE STABILITY OF A PLASMA TORUS AGAINST DISTURBANCES NOT DEPENDENT ON THE AZIMUTH. R. Luest, E. Martensen (Max-Planck-Institut fur Physik und Astrophysik, Munich) and B. R. Suydam (Los Alamos Scientific Lab., N. Mex.). [1961]. 24p. (LADC-5006)

Perturbations of a plasma torus which are independent of azimuth are not covered by the general theory. A method for treating these special modes is presented, the uniqueness theorems are proved, and a rapidly converging numerical scheme for computation is given. It is shown that these modes have the same behavior in a torus of infinite aspect ratio as do the corresponding ones in a cylinder; therefore the infinitely thin torus is stable against these modes. (auth)

**5441** (TID-17370) THE TWO-STREAM INSTABILITY. Technical Report No. 8. B. N. A. Lamborn (Florida. Univ., Gainesville). Dec. 1, 1962. Contract AT(40-1)-2783. 29p.

The two-stream instability has previously been treated by a Fourier-Laplace transformation of the Boltzmann equation. However, the dispersion relation is then expressed as an integrodifferential equation, which can be solved only if certain explicit velocity distributions of the particles are assumed. For a Maxwellian velocity distribution, the solutions to the equation are given in terms of tabulated integrals. It is shown that a dispersion relation for an arbitrary number of components of an infinite beam-plasma system can also be found by examining the coupled differential equations guiding the collective motion of these components. The dispersion relation is then given by the condition that these coupled equations of motion have a simultaneous solution. Using this method, it is not necessary to assume a specific velocity distribution in order to derive a general form of the dispersion relation. Furthermore the extent of the regions of the two-stream instability may be directly related to the physical parameters of the system. For the case of two colliding beams, this treatment shows good agreement with work previously done using the Boltzmann equation. (auth)

**5442** (UCRL-6355) THERMODYNAMIC CYCLING IN MAGNETIC PUMPING. Laurence S. Hall (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 16, 1961. Contract W-7405-eng-48. 17p.

The use of a saw-toothed time-varying magnetic field to provide reversible thermodynamic heating of a plasma by magnetic pumping is discussed. The efficiency is improved over that found in the more conventional use of sinusoidally varying fields, which provide only the irreversible heating guaranteed by the second law of thermodynamics. (auth)

**5443** (WADD-TR-60-676(Pt.II)) OPTICAL METHODS OF MEASURING PLASMA JET TEMPERATURES. PART II. MEASUREMENT BY PHOTOELECTRIC PYROMETRY. H. C. Hottel, G. C. Williams, P. H. Dundas, and W. P. Jensen (Massachusetts Inst. of Tech., Cambridge. Fuels Research Lab.). Nov. 1961. Contract AF33(616)-6570. 46p. (AD-275490)

Two-path optical pyrometry for measurement of plasma jet temperature was studied. A pyrometer was constructed with its detection system consisting of a selected 1P21 photomultiplier associated with an electronic filter tuned to 1 cycle/sec. Comparison between the unknown source and a calibrated filament was made at this frequency for optimum signal-to-noise ratio. The transparency of high temperature plasma necessitated the use of an opacifier for accuracy. The use of sodium as a non-grey temperature indicating probe was investigated. The measurement of integral radiancy was made almost monochromatic by passage through a narrow cut interference filter centered on 5892 Å, having a halfwidth of 7.5 Å, enabling the sodium D line doublet to be selected uniquely but rendering the Beer's law expression inapplicable unless the shape of the emission line is known. Theories of spectral-line broadening suggested the use of Lindholm's theory, which was applied to the interpretation of the pyrometer readings. (auth)

**5444** GROUP VELOCITY OF PLASMA WAVES IN THE PRESENCE OF A MAGNETIC FIELD. B. N. Gershman (Gorkii State Univ., USSR). ARS (Am. Rocket Soc.) J., 32: 1776-7(Nov. 1962).

A derivation of the group velocity of a plasma wave propagating in a uniform plasma contained in a steady magnetic field is presented. Special attention is paid to some features that distinguish a group of plasma waves from ordinary or extraordinary waves. (W.D.M.)

**5445** STATISTICAL PARAMETERS OF AN ELECTROMAGNETIC WAVE AFTER PASSAGE THROUGH AN INHOMOGENEOUS PLASMA IN A MAGNETIC FIELD. N. G. Denisov (Gorkii State Univ., USSR). ARS (Am. Rocket Soc.) J., 32: 1777-82(Nov. 1962).

Perturbation theory is used to calculate the correlation functions for the amplitudes and phases of the field components for a wave transmitted by a randomly inhomogeneous plasma in a magnetic field. The calculations are performed for the normal waves and also for a wave of arbitrary initial plane of polarization. (auth)

**5446** KINETIC EQUATION OF A PLASMA IN WEAK STATIC ELECTRIC AND MAGNETIC FIELDS. M. K. Sundaresan (Carleton Univ., Ottawa) and Ta-You Wu. Can. J. Phys., 40: 1499-1520(Nov. 1962).

The formulation of the kinetic equation for an ionized gas in a weak static electric field and magnetic induction, along the line of the theory of Bogoliubov for a neutral gas is given. It is an extension of the recent work of Wu and Rosenberg on the kinetic equation describing the irreversible processes in a spatially inhomogeneous ionized gas. The equation obtained describes the approach of a plasma in a weak static electric field E and magnetic induction B towards spatial homogeneity and determines the critical field E, for a given (small) inhomogeneity, beyond which the plasma will further digress from spatial homogeneity. For the magnetic induction B, there is no critical value. (auth)

**5447** KINETIC EQUATION OF A PLASMA IN A STRONG STATIC MAGNETIC FIELD. M. K. Sundaresan (Carleton Univ., Ottawa) and Ta-You Wu. Can. J. Phys., 40: 1537-66(Nov. 1962).

The formulation of the kinetic equation of a plasma in a "strong" static magnetic field B is treated, on the basis of the "initial condition" of Bogoliubov that introduces the time arrow, or irreversibility, into the theory. By a "strong" field, it is meant that the cyclotron frequencies of the charged particles $\omega_\sigma = z_\sigma eB/mc$ are large compared with the "collision" frequencies, so that the randomizing effect of the interparticle interactions can be regarded as a "perturbation" on the dynamical motion of the particles. For the spatially homogeneous plasma, the kinetic equation is formulated in an expansion in powers of $(1/\omega_\sigma) \propto (1/B)$. For the spatially inhomogeneous case, the kinetic equation is given in a further expansion in powers of the wave vector $\kappa$ measuring the spatial variation of the inhomogeneity. The theory gives the formal scheme in which the distribution functions $F_1(r,p,\sigma,t)$ of particles of charge $z_\sigma e$ can be obtained to various orders in $1/B$ and $\kappa$. (auth)

**5448** A MULTIPLE-PROBE MICROWAVE SYSTEM FOR PLASMA STUDIES. F. J. Fitz Osborne (RCA Victor Co., Ltd., Montreal). Can. J. Phys., 40: 1620-5(Nov. 1962).

A fast-acting microwave diagnostic system is described which was developed for use with non-repetitive plasmas, such as those in shock tubes and pulsed discharges, and which has proved useful in a wide variety of experimental configurations. The system may be used for either reflection or transmission measurements and gives a polar display of phase and amplitude in conjunction with timing marks. Some of the principal features are wide dynamic range, expansion of high attenuation regions of the display, and a presentation of data which is readily assessed visually. The system has been used at microwave frequencies of 9.2 kMc, 9.7 kMc, 23.5 kMc, and 34.5 kMc, with sampling periods from 0.1 msec to 0.1 μsec at 50% duty cycles. (auth)

**5449** THE ABSENCE OF LANDAU ABSORPTION IN THE NON-LINEAR TREATMENT. Donald Mc Lean. Compt. Rend., 255: 1199-1201(Aug. 13, 1962). (In French)

The approximation used by Landau to study oscillations in a plasma is evaluated using the Montgomery development (Phys. Rev., 123: 1077(1961)). (tr-auth)

**5450** PASSAGE OF HIGH INTENSITY CURRENT IN A FILIFORM DISCHARGE EMITTED BY A FINE POINT. Maurice Skowronek (Laboratoire des Echanges Thermiques, Bellevue, France). Compt. Rend., 255: 1202-4(Aug. 1962). (In French)

A battery of condensers of 4 μf, 90 kv, and 18 kJ is discharged in a narrow channel of ionized air at atmospheric pressure. The maximum current is $1.8 \times 10^5$ amp. Spectrograms taken at different cross sections show the existence of a highly ionized plasma cylinder with maximum diameter of 0.26 cm where the pressure is evaluated at $3 \times 10^3$ kg/cm$^2$. (tr-auth)

**5451** MICROWAVE REFLECTION BY UNIFORM DENSE PLASMAS. Takashige Tsukishima and Susumu Takeda (Nagoya Univ., Japan). J. Appl. Phys., 33: 3290-1 (Nov. 1962).

Convenient formulas are deduced, which relate electron densities and collision frequencies of uniform dense plasmas to two standing wave signals of a probing microwave reflected at a plane boundary of the plasma. In an experiment with a uniform afterglow plasma produced in a waveguide, the electron density from $2 \times 10^{13}$ cm$^{-3}$ to $3 \times 10^{11}$ cm$^{-3}$ is measured with reasonable value of the collision frequency by using a X-band microwave. The technique provides a mean for detecting an electron density as high as $1 \times 10^{16}$ cm$^{-3}$ with the X-band microwave. (auth)

**5452** CALCULATION OF DISTRIBUTIONS IN ONE-DIMENSIONAL PLASMA SHEATHS. D. J. Rose and R. J. Esterling (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 33: 3317-18(Nov. 1962).

In collisionless plasma acceleration and sheath problems, where the potential and one of the fluxes are known, the distribution in energy of flux of the other species can be computed as a solution of Abel's equation. This technique is illustrated, and self-consistent sample solutions are given for ion and electron beams crossing a potential drop, with a concomitant-trapped electron flux. (auth)

**5453** STABILITY OF A HARD-CORE FLUID JET OF SMALL ELECTRICAL CONDUCTIVITY. S. P. Talwar and J. N. Tandon (Univ. of Delhi). J. Fluid Mech., 14: 178-86 (Oct. 1962).

The stability of a hard-core fluid jet is investigated under the assumption of small electrical conductivity of the fluid for parallel and antiparallel current systems. For axisymmetric deformations, the parallel current has a destabilizing influence whereas the antiparallel current improves the stability of the configuration. However, for non-axisymmetric deformations characterized by m = 1, it is shown that the jet becomes unstable in general, both for parallel and antiparallel current systems. The presence of an external conductor is shown to have a stabilizing influence on kink instability. (auth)

**5454** A CORRECTION TO THE APPROXIMATE CONDITION FOR LOCATING THE BOUNDARY BETWEEN A MAGNETIC FIELD AND A PLASMA. Leverett Davis, Jr. (California Inst. of Tech., Pasadena) and David B. Beard. J. Geophys. Res., 67: 4505-7(Oct. 1962).

In applying an approximate boundary condition to the problem of the interface between the solar wind and the geomagnetic field (Beard, D. B., Phys. Rev. Letters, 5: 89-91, 1960), an error was made in the vector formulation of the problem. Therefore the resulting differential equation was valid only in the planes of symmetry. The correct approximate equation is given. (W.D.M.)

**5455** BALL LIGHTNING AND PLASMOIDS. Paul A. Silberg (Raytheon Co., Wayland, Mass.). J. Geophys. Res., 67: 4941-2(Nov. 1962).

A fairly well known and documented fireball phenomenon that is occasionally and accidentally formed aboard certain types of submarines is discussed. The fireball forms when a highly charged battery bank is accidentally connected across a dead generator. The reverse current relay disconnects the circuit, but when the amount of charge left in the batteries creates a sufficiently intense current through the arc, a fireball will float off. (W.D.M.)

**5456** THE EFFECT OF THE INTERACTION OF IONS ON THEIR EQUILIBRIUM CONCENTRATION. S. G. Brush (Univ. of California, Livermore). J. Nucl. Energy: Pt C, 4: 287-9(1962). (UCRL-6653-T)

According to Timan (1954), the electrostatic interaction of ions in an ionized gas tends to favor ionization and at sufficiently high pressures the degree of ionization will start to increase with pressure. By using some recently developed improvements of the Debye-Hückel theory, it is shown that, while in the case considered by Timan this effect does not occur at any pressure for which the theory is valid, it does occur at somewhat lower temperatures. One thus obtains a type of "pressure ionization" from a classical model without invoking volume-dependence of energy levels or similar effects. (auth)

**5457** RELAXATION OF VELOCITY DISTRIBUTION OF IONS IN A PLASMA. Masatada Ogasawara (Tokyo Univ.). J. Phys. Soc. Japan, 17: 1553-62(Oct. 1962).

A relaxation process which is characterized by many relaxation constants is studied in connection with the magnetic pumping. A relaxation equation is derived from two ways, the one is to use the Boltzmann equation and the other the thermodynamics of irreversible processes. The solution is expressed as a sum of many decaying modes and shown in general to have an oscillatory nature about the Maxwellian distribution. Convergence of a series of approximate relaxation constants is shown to be slow. Applicability of the solution is briefly mentioned. In case of an initially elliptic velocity distribution, excitation of neighboring modes cannot be neglected. (auth)

**5458** INTERACTION OF SOLID STATE PLASMON WITH RADIATION. I. ABSORPTION OF ELECTROMAGNETIC RADIATION. Noboru Matsudaira (Tokyo Univ.). J. Phys. Soc. Japan, 17: 1563-70(Oct. 1962).

The interaction of metallic electrons with electromagnetic fields is formulated in the formalism of Bohm and Pines' theory. The formulation has the merit of direct applicability for the case of thin metal foil, which will be treated subsequently. The result is applied to the absorption of radiation by an electron gas with an emission of a plasmon which was also treated recently by Tzoar and Klein by the Green function method. Since the latter work contains some errors we recalculated the absorption cross section numerically and found that the cross section is of the order of $10^{-19}$ cm$^2$. The contributions of the individual electron excitation to the absorption are also considered in order to see the possibility of the experimental detection of the process considered. (auth)

**5459** INTERACTION OF CYLINDRICAL SHOCK WAVE WITH APPLIED MAGNETIC FIELD PARALLEL TO THE AXIS. Akira Sakurai (Tokyo Electrical Engineering Coll., Kanda, Tokyo). J. Phys. Soc. Japan, 17: 1663(Oct. 1962).

The problem of a uniform applied magnetic field in a conducting fluid with a cylindrical shock wave propagating perpendicularly to the magnetic field is considered. The special case of the ratio of the specific heats equals two is treated. (W.D.M.)

**5460** EFFECTS OF LOCALLY APPLIED MAGNETIC FIELD ON PLASMA IN Kr DISCHARGE. Hiroshi Yoshimoto and Yoshihiko Yamashita (Okayama Univ., Japan). J. Phys. Soc. Japan, 17: 1667-8(Oct. 1962).

The effects of a transverse magnetic field on the plasma in Kr discharge was investigated by applying the magnetic field only to a limited part of the positive column having the moving striations. The experimental setup is illustrated. Two pairs of double probes were introduced in the middle part of the tube to measure the longitudinal electric field. (W.D.M.)

**5461** EXPERIMENTS ON NEGATIVE RADIATION TEMPERATURE AT CYCLOTRON RESONANCE IN COLD PLASMAS. Shigetoshi Tanaka, Kenji Mitani, and Hiroshi Kubo (Kyoto Univ.). J. Phys. Soc. Japan, 17: 1800(Nov. 1962). (In English)

Experimental results are described which appear to show the negative temperature phenomena at cyclotron resonance in cold plasmas. Measurements of microwave radiation were performed with a 9,000 mc radiometer. The plasmas were sections of the positive columns of d-c hot-cathode discharge in He, Ne, Kr, and Xe. (W.D.M.)

**5462** "m = 3" INSTABILITIES OBSERVED FOR AN AZIMUTHAL PINCHED PLASMA. Taijiro Uchida (Nihon Univ., Tokyo). J. Phys. Soc. Japan, 17: 1807(Nov. 1962). (In English)

An observation of m = 3 instabilities is reported which shows the transformation of cross section of a compressed plasma column to triangular (m is the azimuthal wave number). It is explained that this instability is due to the radial oscillation of the plasma column appearing after the maximum contraction. The triangularity occurs in a fixed pressure region and stable circular plasmas are obtained at higher pressures. (W.D.M.)

**5463** INTERFEROMETRIC MEASUREMENT OF ELECTRON DENSITY IN SCEPTRE IV. J. Dyson, R. V. Williams, and K. M. Young (Associated Electrical Industries, Ltd., Aldermaston, Berks, Eng.). Nature, 195: 1291-2 (Sept. 29, 1962).

Experiments to determine spatial and temporal variations in the electron density in a hydrogen discharge in Sceptre IV over the density range $10^{14}$ to $10^{16}$/cm$^3$ are described. (L.T.W.)

**5464** ELECTROSTATIC STABILITY OF A COLLISIONLESS PLANE DISCHARGE. F. F. Chen (Princeton Univ., N. J.). Nuovo Cimento (10), 26: 698-716(Nov. 16, 1962). (In English) (MATT-118)

In a collisionless plane discharge the stream of ions falling to the walls is found to be stable against ion wave instabilities for the case in which the ionization function is con-

**stant. If ionization in the sheath region is suppressed, however, ion oscillations may be excited in the sheath. Such oscillations would resemble those recently observed by others. (auth)**

**5465** MECHANISM OF THE FORMATION OF EQUILIBRIUM CONCENTRATION OF THE ELECTRODE MATERIAL IN THE PLASMA OF THE ARC DISCHARGE. I. M. Belousova. Opt. Spectry. (USSR) (English Transl.), 13: 6-10(July 1962).

The mechanism of the formation of equilibrium concentration of the electrode material entering the plasma of an arc discharge was studied. For this purpose, the plasma of the dc arc was transformed for a short period of time from one state into another by superimposing on it an additional current pulse. A decrease of concentration of the electrode material was found with the decrease of pressure of the discharge. This decrease of concentration is connected with the shortening of the time the particles remain in the discharge zone. The formation of the equilibrium spatial distribution of particles, which is characterized by a sharp gradient of the material concentration at the plasma "boundary," takes place in a time of the order of $10^{-4}$ sec. (auth)

**5466** DEVIATION OF MAGNETIC ANNULAR SHOCK-TUBE OPERATION FROM ONE-DIMENSIONAL MODEL. F. J. Fishman and H. E. Petschek (Avco-Everett Research Lab., Everett, Mass.). Phys. Fluids, 5: 1188-95(Oct. 1962).

In a magnetic annular shock tube the gas is pushed axially by an azimuthal magnetic field. Since this field varies inversely as the radius, there are radial nonuniformities in the resulting flow which are analyzed for small values of the ratio $\epsilon$ of annulus spacing to radius. The pressure variation across the annulus at the interface between plasma and driving field results in a tilting of the interface. This flow is analogous to the flow resulting from a dam break in shallow-water theory; it is characterized by a wave of speed $(\epsilon p/\rho)^{1/2}$. The maximum value of $\epsilon$ for which the interface and shock wave remain separated is calculated. Nonuniformities are also produced at the shock front when an azimuthal magnetic field is present ahead of the shock; the shock becomes nonplanar and radial variations in the flow persist far behind the shock. For some cases these nonuniformities are appreciable even for values of $\epsilon$ so small that the interface and shock wave remain separated. (auth)

**5467** LAMINAR HYDROMAGNETIC FLOW IN AN ANNULUS WITH POROUS WALLS. R. K. Jain (Hindu Coll., Delhi), and K. N. Mehta. Phys. Fluids, 5: 1207-11(Oct. 1962).

The exact solution in a closed form of the hydromagnetic equations for an incompressible, viscous, and electrically conducting fluid flow through an annulus with porous walls in the presence of a radial transverse magnetic field is obtained. The solution is reduced to a simpler form with the use of the plausible condition $\nu/\nu_{II} \ll 1$ which holds for most of the fluids used in hydromagnetic experiments. The pressure distribution is discussed for this form of the solution. The problem is also extended to include parallel Couette flow. (auth)

**5468** WAVE PROPAGATION IN A PARTLY IONIZED GAS. B. Samuel Tanenbaum (Raytheon Co., Wayland, Mass.) and David Mintzer. Phys. Fluids, 5: 1226-37(Oct. 1962).

A three-fluid theory (using Maxwell's equations together with a set of coupled hydrodynamic equations for an interacting mixture of electrons, ions, and neutral molecules) is used to examine small-amplitude oscillations in an infinite, homogeneous, partly ionized gas with a uniform external magnetic field. Dispersion relations are obtained when the uniform magnetic field is either parallel or perpendicular to the direction of wave propagation, and the results are interpreted (in the case of negligible collisional damping) by analyzing plots of phase velocity versus frequency. Comparison is made with the simpler one-fluid theories (the magneto-ionic theory, magnetohydrodynamics, and acoustics), as well as with the two-fluid theory for a fully ionized gas. Collisional damping effects are included in all the dispersion relations and are described in detail for the magneto-ionic and magneto-hydrodynamic limits. (auth)

**5469** ABSORPTION OF RADIATION BY THE IONOSPHERE. S. Rand (Inst. for Defense Analyses, Washington, D. C.). Phys. Fluids, 5: 1237-47(Oct. 1962).

The damping of transverse waves, propagating parallel to an external magnetic field, through a low-density plasma is studied. It is found that there is a limitation on the total amount of energy which may be absorbed in a unit volume of the gas. This saturation phenomenon is predicted on the basis of a particular nonlinear relativistic effect. The total amount of energy absorbed is found to be proportional to the two-thirds power of the incident radiation energy flux for a low flux, and proportional to the one-third power for a high flux. (auth)

**5470** CONDUCTIVITY TENSOR AND DISPERSION EQUATION FOR A PLASMA. Robert M. Lewis and Joseph B. Keller (New York Univ., New York). Phys. Fluids, 5: 1248-63(Oct. 1962).

Periodic plane waves are considered in a plasma pervaded by a uniform magnetic field. The appropriate linearized Boltzmann equations for the distribution functions of the electrons and of each type of ion are solved exactly. Collisions are taken into account by the inclusion of a simplified collision term. The solutions are used to compute the electric current, from which the conductivity tensor of each ionic species is found. The total conductivity is then used in Maxwell's equations to determine the electromagnetic field, and this leads to the dispersion equation for plane waves. This equation is solved in various parameter ranges for the case of longitudinal waves when the conductivity of only one species is taken into account. The solutions of Landau, Gordeyev, Gross, Bernstein, and others are recovered when the collision frequency vanishes. In addition, various power series and asymptotic expansions for the conductivity tensor are given, and it is shown to reduce to that of the magneto-ionic theory under suitable conditions. The Appendix contains a systematic study of a function which plays a central role in the theory. (auth)

**5471** WAVE PROPERTIES OF A PLASMA WITH A DOUBLY HUMPED VELOCITY DISTRIBUTION. Setsuo Ichimaru (Univ. of Illinois, Urbana). Phys. Fluids, 5: 1264-71(Oct. 1962).

Properties of growing waves are investigated in a uniform plasma with a doubly humped velocity distribution by studying the character of the boundary curves between growing waves and damped waves. The specific family of distribution functions mainly investigated is one which is composed of a Maxwellian main part plus a small gentle bump (also Maxwellian) on its tail. When a parameter describing the shape of the distribution (the relative strength of the small bump, the separation between the two peaks, etc.) is changed from the region of stability, there is a certain wavenumber $k_c$ at which the onset of plasma-wave instabilities is expected. Studies are made of the conditions for which $k_c$ vanishes, since $k_c = 0$ is associated with a special kind of excitations. A proof is given that the growing wave is not on the same branch of the solution to the dispersion relation as the usual plasma wave. (auth)

**5472** ELECTRICAL CONDUCTIVITY OF A TURBULENT PLASMA. Shoichi Yoshikawa (Princeton Univ., N. J.). Phys. Fluids, 5: 1272-7(Oct. 1962). (MATT-113)

The conductivity of a turbulent plasma parallel to a magnetic field is determined. The plasma is assumed to be homogeneous and the motion of ions is neglected. The ordinary magnetohydrodynamic equations are used. The nonlinear contribution of the product of density and the electric field to the dc conductivity is expressed in terms of the density fluctuations of the plasma. Both weakly ionized and fully ionized plasmas are considered. The nonlinear effect is present either in a weakly ionized plasma or in a fully ionized plasma with adiabatic waves. For example, in a weakly ionized plasma, the conductivity is reduced by the factor $1 - \frac{1}{3}S$ without a magnetic field, and is reduced by the factor $1 - S$ with a strong magnetic field where $S^{1/2}$ is the ratio of ac rms value of the density to the dc density. The noise electric fields are found to increase with external dc electric field, especially for a high magnetic field. (auth)

**5473** PLASMA PRODUCTION BY NEUTRAL-ATOM INJECTION: EQUATIONS AND NUMERICAL SOLUTIONS. A. H. Futch, Jr., W. Heckrotte, C. C. Damm, J. Killeen, and L. E. Mish (Univ. of California, Livermore). Phys. Fluids, 5: 1277-87(Oct. 1962). (UCRL-6728)

Differential equations and their solutions for the formation of a high energy plasma by the injection and trapping of energetic atoms in a magnetic-mirror geometry are discussed. The approach differs from previous treatments in that the finite orbit size of the ions and the spatial dependence of the trapping process are included in the equations. By including the spatial dependence it was possible to evaluate the effect of charge exchange of trapped ions with neutral-beam atoms. Although not affecting the total number of trapped ions, this process results effectively in a change of the mean radial position of the ions. The effect on plasma growth rates of charge exchange of the trapped ions with beam atoms was found to be essentially negligible. The solutions for ion density vs time exhibit growth rates similar to those obtained when the plasma density is assumed to be spatially constant. Background gas variations during plasma buildup have also been investigated. Under the present set of conditions the effect of "gas burnout" and plasma pumping are small, even at high densities. (auth)

**5474** CURRENT-LAYER DIFFUSION IN A ONE-DIMENSIONAL PINCH. Theodore J. Falk and Donald L. Turcotte (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 5: 1288-92(Oct. 1962).

Diffusion of the current layer at the surface of a compressible electrically conducting gas in a one-dimensional pinch is analyzed in the limit of large time. Magnetohydrodynamic equations including finite scalar electrical and thermal conductivities are used, and the degree of ionization is taken to be constant. A parameter, which is proportional to the diffusion speed divided by the sound speed, is used to show that the inertia terms may be discarded in large-time high-electrical-conductivity problems. Some numerical results for the temperature, velocity, and magnetic field within the current layer are presented in terms of a similarity variable. In the cases analyzed the gas boundary is displaced from its infinite conductivity position by an amount which is of the order of magnitude of the current-layer thickness. Comparison of constant conductivity with temperature-dependent conductivity results shows that Joule heating at the gas boundary improves confinement if the initial conductivities are low. (auth)

**5475** EXPERIMENT ON THE SPATIAL CONFINEMENT OF PLASMA IN THE HELIOTRON B MAGNETIC FIELD. Kōji Uo, Akihiro Mōri, Hiroshi Oshiyama, Risō Katō, and Keishi Ishii (Kyotto Univ.). Phys. Fluids, 5: 1293-1300(Oct. 1962).

A magnetic field is produced by an electric current in a series of pair coils wound around the discharge tube at regular intervals. The electric current in each coil of the pair differs both in intensity and direction. The lines of force near the tube axis undulate without crossing the wall, while those near the tube wall cross the wall. Thus the high-temperature plasma can be produced by Ohmic heating in the central region of the field. Experiments were carried out in order to verify the spatial confinement of the plasma in this field. The plasma current flows only within the central region whose mean-cross-section diameter is about 3 cm, and the plasma has a sharp boundary. Outside the region there is no current. The spectra from the hydrogen discharge are mainly composed of the pure Balmer series, and the impurity spectral lines are very weak or hardly perceptible. From these experimental results, it can be concluded that the hot plasma is almost perfectly isolated from the stainless-steel-tube wall by the Heliotron magnetic field and has very low impurity level. (auth)

**5476** GRAVITY WAVES OF A CONDUCTING FLUID IN A HORIZONTAL MAGNETIC FIELD. Takeo Sakurai (Kyoto Univ.). Phys. Fluids, 5: 1304-5(Oct. 1962).

The gravity waves of a perfectly conducting fluid under the influence of a horizontal magnetic field are considered. It is assumed that two different fluids are in contact with an infinite horizontal interface in between, and in each fluid region a uniform magnetic field is applied. Both fluids are incompressible perfect and have infinite electrical conductivity. The following two cases are considered: the lower fluid has infinite depth, and the lower fluid region is a thin layer. (W.D.M.)

**5477** INTERACTION BETWEEN PLASMA AND A TWO-DIMENSIONAL MAGNETIC DIPOLE. W. H. Bostick, H. Byfield, Y. Nakagawa, and D. Wells (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Fluids, 5: 1305-7(Oct. 1962).

Theory predicts that when a stream of perfectly conducting fluid impinges on a magnetic field, there may be a hydromagnetic interaction strong enough to compress the magnetic field, which leads to the formation of a boundary surface between the fluid and the field. The formation of a cavity in a copper plasma streaming around a two-dimensional dipole was observed which qualitatively confirmed the predictions of Hurley. (W.D.M.)

**5478** FOKKER-PLANCK COEFFICIENTS FOR ONE-DIMENSIONAL PLASMA. O. Eldridge and M. Feix (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 5: 1307-8(Oct. 1962).

A homogeneous, one-dimensional plasma with one species of particles plus a neutralizing background is considered. The test particles are a set of sheets which are singled out from a large number of sheets in thermal equilibrium. It is assumed that the distribution function of the test particles obeys an equation of the Fokker-Planck type. (W.D.M.)

**5479** NONEQUILIBRIUM IONIZATION IN A MAGNETOHYDRODYNAMIC GENERATOR. Frank Robben (General Electric Space Sciences Labs., Philadelphia). Phys. Fluids, 5: 1308-9(Oct. 1962).

A model for nonequilibrium ionization applicable to a magnetohydrodynamic generator has been developed which predicts a large increase in the plasma conductivity, if the plasma is a partially ionized monatomic gas whose temperature is such that the equilibrium ionization is small. Experiments designed to test the validity of this model were carried out. Measurements of the plasma conductivity in the absence of a magnetic field show fair agreement with the model, but, with the plasma flowing through a field of 13 kG, a large sheath voltage drop existed at the electrodes and prevented a significant measurement of the plasma conductivity. (W.D.M.)

**5480** INTERACTION OF MICROWAVES WITH EXPLODING WIRES. D. B. Medved (General Dynamics Astronautics, San Diego, Calif.), W. Turnbull, and E. T. Lipscomb. Phys. Fluids, 5: 1309-10(Oct. 1962).

In the course of measurements of the microwave propagation characteristics of the $TE_{10}$ mode in a waveguide in which the wire to be exploded is perpendicular to the $TE_{10}$ mode electric-field vector, it was observed that an appreciable amount of microwave attenuation occurred during the dwell time. The attenuation corroborates, qualitatively, previous observations of nonzero conductivity during the dwell obtained using special current probes. (W.D.M.)

**5481** SOME REMARKS ON NEGATIVE ABSORPTION. Toshimitsu Musha (Electrical Communication Lab., Tokyo). Phys. Fluids, 5: 1310-11(Oct. 1962).

Negative absorption of electromagnetic waves by a partially ionized plasma due to collisions of electrons with neutral gas atoms was discussed (Bekefi, G., et. al., Phys. Fluids, 4: 173) as stimulated bremsstrahlung. The mechanism of this kind of negative absorption is explained as negative polarization of the ionized gas. The relation between negative absorption and negative temperature is discussed. (W.D.M.)

**5482** MEASUREMENT OF THE PROPERTIES OF PLASMA EDDIES PRODUCED BY SHEAR IN VELOCITY IN A MAGNETIC FIELD. Winston H. Bostick (EURATOM-CEA, Fontenay-aux-Roses, France). Phys. Fluids, 5: 1406-9(Nov. 1962).

Velocity shear is deliberately introduced by firing two plasma guns, laterally displaced, at one another across a magnetic field. Double-probe measurements of electric fields (and hence velocity) in the plasma clearly show the existence of traveling vortices or eddies which contain most of the plasma. Simultaneous velocity and density profiles of eddies have been obtained and examples are shown. (auth)

**5483** SOME GENERAL CHARACTERISTICS OF TWO-DIMENSIONAL INCOMPRESSIBLE MAGNETOHYDRODYNAMIC FLOWS. C. H. T. Pan (Mechanical Technology Inc., Latham, N. Y.). Phys. Fluids, 5: 1410-15(Nov. 1962).

The velocity field of a liquid conductor will be planar, with all field quantities being invariant in the normal (z) direction, for two different categories of conditions. (1) Planar components of B and J are parallel. This poses a strong restriction on the electrical and magnetic boundary conditions. The magnetic field has a nontrivial influence on the flow field only when $J_z$ is nonuniform. $B_z$ has a precise analog in the laminar heat convection in a liquid with negligible viscous dissipation. (2) The total current field is normal to the planar velocity field. Consequently, $B_z$ must be uniform. There is a space-charge density proportional to the product of $B_z$ and vorticity. If the B field is both static and coplanar with the velocity field, then the electric field must be uniform parallel to the normal direction, and have only a higher-order influence on the velocity field, if the magnetic Reynolds number is small. (auth)

**5484** STABILITY OF A HETEROGENEOUS SHEAR LAYER IN A MAGNETIC FIELD. J. Menkes (California Inst. of Tech., Pasadena). Phys. Fluids, 5: 1424-7(Nov. 1962).

The stability of a horizontal, heterogeneous shear layer subject to a vertical magnetic field of constant magnitude has been investigated. The stabilizing effect of the magnetic field is clearly demonstrated. The behavior of a medium with an exponential density distribution is considered in detail. (auth)

**5485** TRANSVERSE MAGNETOHYDRODYNAMIC FLOW PAST A SEMI-INFINITE PLATE. James Radlow (Adelphi Coll., Garden City, N. Y.) and William B. Ericson. Phys. Fluids, 5: 1428-34(Nov. 1962).

A viscous, incompressible, conducting fluid flows past a semi-infinite flat plate; the free-stream velocity of the fluid is taken parallel to the plate, and there is an applied magnetic field perpendicular to the plate. Physical arguments are given for a certain linearization of the basic steady-state equations, and the linearized equations are solved by an approximation method based on the Wiener-Hopf technique. An error estimate for the approximation is derived. The induced magnetic field, measured at the plate, is found to differ from the applied magnetic field by a multiplicative factor, whose value depends on the physical properties of the fluid and is constant for any given fluid. If the conducting fluid is a liquid metal (mercury or liquid sodium), edge effects can reasonably be neglected in calculating skin friction at the plate. An experimental study of the physical conclusions should be relatively manageable. (auth)

**5486** TRAPPING INSTABILITIES IN A SLIGHTLY INHOMOGENEOUS PLASMA. Nicholas A. Krall and Marshall N. Rosenbluth (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 5: 1435-46(Nov. 1962). (GA-2356)

The stability of an infinite collisionless plasma with a small density gradient in the x direction (using the collisionless Boltzmann equation and Maxwell's equations) confined by a static magnetic field in the z direction, is studied. Unstable modes are found at frequencies near multiples of the ion-cyclotron frequency $\Omega_i$. These modes are electrostatic oscillations transverse to the magnetic field, and have very short wavelengths $\lambda \sim \nu_d/\Omega_i$, where $\nu_d$ is the (small) drift occasioned by the magnetic-field inhomogeneity. The phase velocity of the wave is comparable to $\nu_d$, and resonant interaction leads to the growth. Typical growth rates are large, $\alpha \sim (m_e/m_i)\,\Omega_i$, but the effect of the instability is minimized by the extremely short wavelength. (auth)

**5487** MODIFICATION FOR MAGNETOHYDRODYNAMIC SHOCK STRUCTURE WITHOUT COLLISIONS. Cathleen S. Morawetz (New York Univ., New York). Phys. Fluids, 5: 1447-50(Nov. 1962).

It is shown that the steady-state shock structure given earlier [C. S. Morawetz, Phys. Fluids, 4: 988(1961)] is valid only for zero-temperature electrons. However, certain modifications of the asymptotic development of the electrons permit one to show that the same shock form will appear if the electrons have a relative thermal speed of the order $\epsilon^{-\nu}$, where $\epsilon^2$ is the mass ratio and $\nu$ satisfies $\frac{1}{2} < \nu < 1$. This corresponds to a ratio of electron to ion temperature of the order $\epsilon^{2(1-\nu)}$. (auth)

**5488** STRUCTURE OF COLLISION-FREE MAGNETOHYDRODYNAMIC WAVES. Theodore A. Wilson (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 5: 1451-5(Nov. 1962).

Properties of the two-fluid plasma equations which lead to a partial theoretical model for the collisionless shock wave are investigated. First, a nonlinear symmetric-pulse solution to the two-fluid equations for a cold collisionless plasma is described. The propagation speed of the pulse is between the Alfvén speed and the fast-wave speed, and the pulse thickness is of the order of $(m_ic^2/4\pi e^2N)^{1/2}$, except for geometries in which the wave normal makes an angle of the order of $(m_e/m_i)^{1/2}$ or less with the upstream magnetic field. An effective conductivity is then introduced in the equations of motion of the plasma and a shock thickness is estimated. The calculated dependence of shock thickness on Mach number is shown to agree with the available experimental data. Finally, the growth of a sinusoidal pinch instability of a current-carrying plasma is shown to have the average effect of a finite conductivity as was postulated. (auth)

**5489** SIMPLE WAVES AND SHOCKS IN MAGNETOHYDRODYNAMICS. Ihor O. Bohachevsky (New York Univ., New York). Phys. Fluids, 5: 1456-67(Nov. 1962).

A theorem due to P. Lax asserts that transition across a weak shock, when expanded in powers of a suitable shock-strength parameter, agrees with the transition across the simple wave of the same kind up to the terms of second order, inclusive. This theorem, however, does not apply to the shock velocity $\nu$; it is shown that $\nu$ can also be determined up to second-order terms from the simple-wave relations. The above result is used to extend Friedrichs' theory of simple wave-weak shock interactions from gas dynamics to a general system of conservation laws. To illustrate the general theory, the treatment of a special system of conservation laws, namely, the Lundquist equations, and an explicit description of simple magnetohydrodynamic waves are given. The latter includes construction of Riemann invariants and the expansion of simple-wave relations into power series up to quadratic terms, inclusive. In connection with this work, a special approximation is proposed to describe the switch-on waves. Shocks are described by analogy with simple waves. To illustrate the necessary modifications of gas-dynamic formulas, the above results are used to discuss in detail the location of the point at which the shock forms. In particular, conditions are given under which the magnetohydrodynamic shocks develop sooner or later than the gas-dynamic. (auth)

**5490** PROPAGATION OF ULTRASONIC WAVES IN PLASMAS. M. Surdin (CEN, Saclay, France and North Carolina State Coll., Raleigh). Phys. Fluids, 5: 1479-80 (Nov. 1962).

A theoretical analysis is made of an experiment in which an ultrasonic wave of variable frequency is launched in a plasma. The following simplifying approximations are made: (a) The charge neutrality is preserved within the plasma to a very high degree. Deviations from electrical neutrality are considered only in Poisson's equation. (b) $m/M << 1$. (c) The electric resistivity is zero; (d) The plasma considered is isothermal, i.e., $T_e = T_i = T$, and the ion and electron gases have the same number of degrees of freedom, i.e., $\gamma_e = \gamma_i = \gamma$. (L.T.W.)

**5491** DAMPING OF QUANTIZED LONGITUDINAL ELECTRON OSCILLATIONS IN A NONDEGENERATE PLASMA. James F. Morris (National Aeronautics and Space Administration, Cleveland). Phys. Fluids, 5: 1480-1 (Nov. 1962).

A new damping factor obtained from the dispersion expression for longitudinal electron oscillations in a quantum thermal plasma is presented. The conditions for this quantum damping effect are those covered by the random-phase approximation above the degeneracy temperature. (L.T.W.)

**5492** PRODUCTION OF A HOT ROTATING PLASMA. Klaus Halbach, William R. Baker, and Robert W. Layman (Univ. of California, Berkeley). Phys. Fluids, 5: 1482-3 (Nov. 1962). (UCRL-10269)

The design and operation of Homopolar V are described. The device was designed so that there would be no drift-velocity (or voltage) limit as had been encountered in earlier experiments. Experiments with the device show that rotating plasmas need not suffer from a serious velocity limit, at least at early times, and the discharge seems capable of producing a dense plasma with ion energies of thermonuclear interest, at least transiently. (L.T.W.)

**5493** NEGATIVE RESISTANCE DUE TO RAMSAUER-EFFECT IN PLASMAS. S. Ohara (Electrical Communication Lab., Tokyo). Phys. Fluids, 5: 1483-4(Nov. 1962).

A new differential negative resistance in a plasma was obtained using gases such as xenon and krypton. Probe characteristics by the Langmuir method showed negative resistances in electron saturation regions; probe currents decreased with increasing probe voltage above the space potentials of plasmas. (L.T.W.)

**5494** POISEUILLE PLASMA EXPERIMENT. H. W. Emmons and R. I. Land (Harvard Univ., Cambridge, Mass.). Phys. Fluids, 5: 1489-1500(Dec. 1962).

The flow of gas and electric current simultaneously through a tube provides an experimental arrangement for the precise experimental study of the flow of high-temperature gases and a precise mathematical theory. The precision experimental technique and some initial experimental results, together with a simplified theory, are presented. Mean electrical conductivity and kinematic viscosities are given for a number of gases. The arc performance is shown to be predictable with precision by a simple discontinuous model of the plasma properties that is capable of wide exploitation in magnetohydrodynamics. (auth)

**5495** PLASMOID DIPOLE ROTATION IN A THETA PINCH. G. L. Clark and R. F. Wuerker (Space Technology Labs., Inc., Los Angeles). Phys. Fluids, 5: 1503-6(Dec. 1962).

The behavior of the toroidal plasmoid formed in a theta pinch, produced by trapping of magnetic field lines, is photographed with an ultra-high-speed image-converter camera. Photographs show the plasma ring rotating about an axis perpendicular to the applied magnetic field. This rotation is seen not only as a possible explanation for the sudden disappearance of the trapped magnetic field, but as a mechanism for accelerating the ions caught in the plasmoid. An upper bound to the ion energies obtainable through such a mechanism is found. (auth)

**5496** ANOMALOUS DIFFUSION ARISING FROM MICROINSTABILITIES IN A PLASMA. William E. Drummond and Marshall N. Rosenbluth (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 5: 1507-13(Dec. 1962). (GA-2647(Rev.))

A plasma is considered in which a Maxwellian distribution of electrons with thermal velocity $v_e$ and drift velocity $v_D$ is drifting relative to a Maxwellian distribution of ions with thermal velocity $v_i$. For $v_D \lesssim v_e$ the ion acoustic waves are stable; however, electrostatic ion cyclotron waves are unstable for $v_D \gtrsim 5v_i$. In the case when $5v_i \lesssim v_D \lesssim v_e$, and $T_e/T_i < 2$ the electrostatic ion cyclotron waves grow to a nonlinear equilibrium spectrum. This spectrum of waves leads to a diffusion of electrons across the field lines with a diffusion coefficient $D = \alpha\rho_e^2\Omega_e$, where $\rho_e$ is the electron Larmor radius and $\Omega_e$ is the electron Larmor frequency. $\alpha$, the ratio of the resulting diffusion coefficient to the Bohm diffusion coefficient, is found. (auth)

**5497** HIGH-FREQUENCY CONDUCTIVITY OF A FULLY IONIZED PLASMA. Carl Oberman, Amiram Ron, and John Dawson (Princeton Univ., N. J.). Phys. Fluids, 5: 1514-22(Dec. 1962).

A complete classical derivation of the frequency-dependent conductivity is presented that properly takes into account collective dynamics. This treatment rests on the joint solution of the first two members of the "BBGKY" hierarchy, in the plasma limit, when both are able to change on the same time scale. For arbitrary frequencies this leads to an integral equation for the one-particle distribution function, which can be solved by conventional variational and/or numerical procedures. For frequencies high compared to the collision frequency, an explicit statement of the conductivity is possible. This high-frequency limit is further examined in the limit of small electron-to-ion mass ratio. (auth)

**5498** CLOSE COLLISIONS IN A PLASMA. David E. Baldwin (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 5: 1523-30(Dec. 1962).

A two-body distribution function in a plasma is developed for use in a kinetic equation for the one-body distribution function. The kinetic equation is obtained for a uniform plasma for circumstances in which the time dependence of higher-order distribution functions can be assumed to occur within a functional dependence on the one-particle distribution function. The resulting interaction term contains no divergent integrals, and is considered accurate to first order in $(e^2/KT\lambda_D)$. The interaction term is composed of two parts. The first is a Boltzmann collision integral with a Debye-shielded interaction. The second term arises from the deviation of the shielding cloud from a Debye shield and is of the Fokker-Planck form, the coefficients of which are finite and well-behaved. (auth)

**5499** FORMATION OF DRIFT INSTABILITIES BY COLLISIONAL RELAXATION OF HIGH-ENERGY PARTICLES. H. Dreicer and R. Mjolsness (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 5: 1531-44(Dec. 1962). (LADC-5072)

The relaxation of a small group of fast test electrons as a result of two-body Coulomb encounters with slow field electrons and ions orbiting in a magnetic field is investigated. The analysis is based upon an asymptotic form of the Fokker-Planck equation, which includes the slowing down in speed as well as the angular scattering of the test electrons. The derivation and analytic solution of this equation is presented, and is used to illustrate a case where collisional relaxation of the test electrons alone is responsible for the formation of a second peak in the one-dimensional electron velocity distribution. The maximum growth rate for the resulting electrostatic drift instability is calculated in the limit in which the second peak is much smaller than the main peak, and is found to be proportional to the ratio of test to field particle density. The results are used to suggest an explanation of the several unstable current steps observed in the stellarator during its crowbarred relaxation phase. (auth)

**5500** INTERACTION BETWEEN COLD PLASMAS AND GUIDED ELECTROMAGNETIC WAVES. [PART II]. Lyman Mower (Massachusetts Inst. of Tech., Cambridge) and S. J. Buchsbaum. Phys. Fluids, 5: 1545-51(Dec. 1962).

The interaction between a cylindrically symmetric anisotropic plasma column and bounded electromagnetic waves is analyzed theoretically. The properties of a cylindrical cavity coaxial with a cold plasma column, with or without a coaxial static magnetic field, are determined. The shift in the resonant frequency of the cavity-plasma system is calculated in the high-electron-density limit and compared with a numerical solution. (auth)

**5501** INTERACTION BETWEEN A RADIO WAVE AND A HIGH-TEMPERATURE PLASMA. Toyoki Koga (Univ. of Southern California, Los Angeles). Phys. Fluids, 5: 1552-7 (Dec. 1962).

The effect of the temperature of a fully ionized plasma on its conductivity to a radio wave is investigated, taking into consideration the finite wavelength of the radio wave. The order of the effect is $kT/(ma^2)$, where $m$ is the mass of an electron and $a$ the phase velocity of the wave. The relativistic effect is not considered. (auth)

**5502** BREMSSTRAHLUNG FROM A PLASMA. David B. Chang (Univ. of California, San Diego, La Jolla). Phys. Fluids, 5: 1558-63(Dec. 1962).

The effect of correlations on bremsstrahlung from a plasma is studied by using in Kirchhoff's law an absorption coefficient obtained from a Boltzmann-Fokker-Planck equation. A simple derivation of the Fokker-Planck coefficients is given by relating them to d-c coefficients. A dispersion formula giving the principal behavior of the absorption coefficient is obtained from a first-iterate solution of the Fokker-Planck equation, treating the scattering of electrons by ions as a perturbation. The absorption coefficient reduces to the incoherent radiation result at frequencies much higher than the plasma frequency. At the plasma frequency the coefficient is greater than the incoherent absorption coefficient. The effect of surface reflections on the net emission is discussed. (auth)

**5503** PLASMA CORRECTION TO SINGLE-PARTICLE CYCLOTRON RADIATION. David B. Chang (Univ. of California, San Diego, La Jolla). Phys. Fluids, 5: 1564-70(Dec. 1962).

The saddle-point evaluation used to obtain the $O(\omega_p^2/\omega\omega_H)$ absorption coefficient for single particle cyclotron radiation from a mildly relativistic plasma is extended to include terms of $O(\omega_p^4/\omega^2\omega_H^2)$ describing collective plasma effects, where $\omega_p$, $\omega_H$, and $\omega$ are the plasma frequency, electron cyclotron frequency, and observed frequency respectively. The $O(\omega_p^4/\omega^2\omega_H^2)$ correction modifies the $O(\omega_p^2/\omega\omega_H)$ calculation through the introduction of an additional steepest descent path; through the inclusion of additional terms in the expansion of the dispersion formula; by changing the location of the saddle points; and by altering the expressions evaluated at the saddle points. For a typical thermonuclear plasma, the fractional $O(\omega_p^4/\omega^2\omega_H^2)$ correction to the absorption coefficient for propagation perpendicular to the magnetic field is found to be approximately $-\omega_p^2/\omega\omega_H$. (auth)

**5504** INTERACTION BETWEEN A PLASMA AND THE EXTERNAL CURRENT AND FLUX. T. H. Jensen and H. G. Voorhies (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 5: 1571-6 (Dec. 1962).

The external current and flux in plasma devices are studied, in order to obtain information on the plasma by the observation of these quantities. Two devices are investigated, namely the long mirror and the cusp. The following quantities can be found approximately: total kinetic energy of the plasma; energy exchange between plasma and field; and energy exchange between the plasma and the surroundings. (auth)

**5505** STRUCTURE OF STRONG PLASMA SHOCK WAVES IN A TRANSVERSE MAGNETIC FIELD. G. G. Comisar (Aerospace Corp., Los Angeles). Phys. Fluids, 5: 1590-6(Dec. 1962).

The structure of a plane stationary shock wave in a plasma with a transverse magnetic field is explored by using a restricted variational principle to evaluate the adjustable factors of a bimodal representation of the ion and electron distribution functions. The resulting solutions, in the strong shock limit, indicate that the particle number densities are essentially those of the nonmagnetic case, and that the transverse magnetic field departs considerably from the usual frozen-in field profile, as a result of local dissipative effects of electrical conductivity. (auth)

**5506** NONLINEAR PROPAGATION OF ELECTROMAGNETIC WAVES IN A PLASMA. Mahendra Singh Sodha and Carl J. Palumbo (Republic Aviation Corp., Mineola, N. Y.). Phys. Fluids, 5: 1664-5(Dec. 1962).

The propagation of electromagnetic waves in plasma is investigated, taking into account variations in the electron mean free path in the plasma. (T.F.H.)

**5507** ELECTRODYNAMIC PROPERTIES OF A QUANTUM PLASMA IN A UNIFORM MAGNETIC FIELD. John J. Quinn and Sergio Rodriguez (RCA Labs., Princeton, N. J.). Phys. Rev., 128: 2487-93(Dec. 15, 1962).

A quantum-mechanical derivation is given of the conductivity tensor of a free electron gas in the presence of a d-c magnetic field and of an arbitrary electromagnetic disturbance. The results obtained are applied to study some simple problems on the dispersion and attenuation of sound waves in metals in the presence of a magnetic field. In particular, it is shown that both the velocity and attenuation of longitudinal acoustic waves travelling parallel to the magnetic field exhibit oscillations as a function of the magnetic field under suitable conditions. (auth)

**5508** HARRISON-THOMPSON GENERALIZATION OF BOHM'S SHEATH CONDITION. L. S. Hall (Univ. of California, Livermore). Proc. Phys. Soc. (London), 80: 309-11 (1962). (UCRL-6868)

Harrison and Thompson (1959) generalized Bohm's condition for the formation of a sheath in an electrical discharge. One point of their generalization which restricts the claim that their analysis is applicable to an arbitrary incident ion velocity distribution is discussed. The restriction lies in the divergence of their expansion of the integral for the ion density. A corrected analysis is suggested, and the physical interpretation of the results is described briefly. (D.L.C.)

**5509** NON-LINEAR PROPAGATION OF AN AMPLITUDE-MODULATED ELECTROMAGNETIC WAVE IN A PLASMA. M. S. Sodha and C. J. Palumbo (Republic Aviation Corp., Mineola, N. Y.). Proc. Phys. Soc. (London), 80: 1155-60(Nov. 1, 1962).

The authors have studied the change in modulation of an amplitude-modulated electromagnetic wave in a Lorentzian plasma by using the geometrical-optics approximation as well as the wave equation. Expressions for the quadratic dependence of the conductivity on the amplitude of the electric vector have been obtained and used in the present investigation. A critical comparison of the results obtained by the two methods has been made. (auth)

**5510** TRANSPORT COEFFICIENTS OF QUANTUM PLASMA. Mitsuo Watabe (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 28: 265-82(Aug. 1962). (In English)

The two time Green's function method is applied to calculate the transport coefficients of an electron gas. The sequence of equations for Green's functions is derived, and it is shown that the results corresponding to the random phase approximation (including the exchange effects) can be obtained by terminating this sequence at the first stage. Proceeding to the second stage, one can quite naturally take the shielding effects and the plasma oscillation into account. Some discussions are made about the derivation of the kinetic equation for quantum plasma. (auth)

**5511** THEORY OF RESONANCE PROBE. Yoshi H. Ichikawa (Nihon Univ., Tokyo) and Hideo Ikegami. Progr. Theoret. Phys. (Kyoto), 28: 315-22(1962). (In English)

A theoretical analysis is made of the resonance phenomena in the r-f probe experiments of Takayama et al. The Boltzmann-Vlasov equation is solved under the action of an external r-f electric field. The solution gives the resonance peak of the d-c component of the electron current to the probe at the plasma frequency. (auth)

**5512** APPROXIMATION FORMULAS FOR NONRELATIVISTIC BREMSSTRAHLUNG AND AVERAGE GAUNT FACTORS FOR A MAXWELLIAN ELECTRON GAS. P. J. Brussaard (F.O.M. Instituut voor Plasmafysica, Jutfaas, Netherlands) and H. C. van de Hulst. Revs. Modern Phys., 34: 507-20(July 1962).

The most important approximations that permit the rapid calculation of numerical results for nonrelativistic bremsstrahlung and gaunt factors for a Maxwellian electron gas in the entire energy and frequency ranges with an accuracy of one percent are collected. (L.T.W.)

**5513** REFLECTION OF RADIATION FROM A MOVING PLASMA IN A SEMICONDUCTOR WITH A CURRENT IN A MAGNETIC FIELD. G. A. Askarian (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 43: 1104-5(Sept. 1962). (In Russian)

The identification and uses of Doppler mixing during the reflection of electromagnetic waves from a moving plasma in a semiconductor are considered. The change in frequency of the reflected light, $\Delta\omega$, is equal to $u(t)\,\omega_0 N/c'$, where $\omega_0$ is the frequency of the unmixed light, $c'$ is the speed of light in the layer between the semiconductor surface and the reflecting boundary of the plasma, and N is the reflection number between the same two surfaces or boundaries. It was found that even for a single reflection $\Delta\omega/\omega$ can be as high as $10^{-3}$. The shift in the plasma boundary can be used to change the reflection coefficient of the interfering waves resulting from the reflection from the semiconductor and plasma boundaries. (TTT)

**5514** DRIFT INSTABILITIES DUE TO COLLISIONAL RELAXATION OF HIGH ENERGY PARTICLES. H. Dreicer and R. Mjolsness (Los Alamos Scientific Lab., N. Mex.). p.1689-98 of "Proceedings of the Fifth International Conference on Ionization Phenomena in Gases, Munich 1961." Amsterdam, North-Holland Publishing Co., 1961. (TID-13610; LADC-4899)

The collisional relaxation of a group of fast test particles in a plasma is examined with the help of an asymptotic form of the Fokker-Planck equation. The treatment indicates that relaxation can cause the formation of second peaks in the plasma velocity distribution, even if the distribution is initially single peaked. (auth)

**5515** THE PROBLEM OF GAS PURITY IN PLASMA PHYSICS AND TECHNOLOGY. S. J. Buchsbaum (Bell Telephone Labs., Inc., Murray Hill, N. J.) and G. A. Sawyer. p.54-61 of "Symposium on Major Effects of Minor Constituents on the Properties of Materials. ASTM Materials Science Series 2. ASTM Special Technical Publication No. 304." Philadelphia, American Society for Testing and Materials, 1962. (LADC-5115)

Although impurities can affect the properties of a plasma in many ways, their effects can be broadly classified into two classes: impurities introduce into the plasma (either through ionization or attachment) unknown ion species; and impurities introduce mechanisms for large energy losses.

These effects, however, are not always harmful. In fact, they are put to use in many devices, some of which are described. (auth)

**5516** AN EXPERIMENTAL STUDY OF RAYLEIGH-TAYLOR INSTABILITY IN PLASMA. Hillman Dickinson. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1961. 47p.

A clear experimental observation of Rayleigh-Taylor, flute-type instability in a high temperature plasma expanding across a magnetic field, was made with time-delay, Kerr cell, sequence photography. The wavelength and growth rate of the instability were measured as a function of time for various values of external magnetic field and background gas pressure. With interface decelerations of about $10^9$ m/sec$^2$ the instability developed in 1–4 microseconds with wavelengths of about $10^{-2}$ m. After 1–4 microseconds the flutes grew with constant velocity. (Dissertation Abstr., 23: No. 4, 1962)

**5517** THEORETICAL INVESTIGATION OF PLANE, HYDROMAGNETIC SHOCKS IN A COLD PLASMA. Robert Gustav Loewy. Thesis, Philadelphia, Univ. of Pennsylvania, 1962. 94p.

A planar shock wave is postulated travelling through an infinite, completely ionized medium with finite conductivity, in a direction perpendicular to an applied, uniform, plane magnetic field. The governing multi-fluid continuum equations were formulated in shock coordinates, considering the situation to be steady, one-dimensional, and nonrelativistic. Self-induced electric and magnetic fields were accounted for, as were diffusion forces between species, but all other physical quantities relating to the peculiar velocities of the particles comprising the species–such as viscosity, heat conduction, pressure, and temperature–were neglected. A criterion is suggested defining the limits of applicability of the cold gas approximation when diffusion terms are included. The equivalent of Rankine-Hugoniot relations for the cold gas was derived for an n-component multi-fluid. The equations show the same inverse relation between velocity ratio and density ratio and between velocity ratio and magnetic field intensity ratio as was derived for the classical one-fluid magneto-gasdynamic case. Specializing to the case of a two fluid, the small disturbance characteristics of the governing equations were developed. The exact polynomial for the characteristic roots is a complex quartic. By considering the orders of magnitudes of the numbers likely to be of interest, it is shown that an excellent approximation is given by a quadratic. This, in turn, provided a closed form expression for calculating roots with the divergent characteristics indicative of the approach to a shock. The cross-over point from convergence to divergence is an Alfven Mach Number of unity. It is seen that all such roots are nonoscillatory in nature. From the form of the quadratic solution a criterion for determining orders of magnitude of the diffusion coefficient which will affect the divergent characteristics is immediately obvious. The results of several numerical examples are given. A small disturbance mode was seen to be only slightly more sensitive to the diffusion coefficient than the divergent root itself. Further, the velocity components perpendicular to the direction of shock propagation in the divergence mode were insensitive both to diffusion coefficient and to Alfven Mach Number for both species. Numerical integration of the complete non-linear equations was attempted using large-scale automatic digital computing equipment. The sensitivity of the calculation was such as to make use of a predictor-corrector type of integration impractical because of round-off errors. A Runge-Kutta-Gill procedure was found to be more successful, and some results presenting fine structure of the leading edge of the shock show oscillations in the E-field, as the velocity components diverge, which were close to the plasma frequency. (Dissertation Abstr., 23: No. 4, 1962)

**5518** PLASMA THEORY APPLIED TO BALL LIGHTNING. Donald Gilbert Carpenter. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1962. 125p.

An investigation was made of the possible generation of ball lightning starting with an assumed initial condition in plasma. A specific occurrence of ball lightning on October 13, 1960 is discussed. It suggested the possibility of inadvertent man-made ball lightning, and tended to disprove Kapitza's standing wave theory. The initial condition postulated that a rod of electrical current existed in the center of a swirl of turbulent air. There were no sources of electrical potential. The following relations were applied assuming air was nitrogen gas: Maxwell's equations, conservation of relative charge, and Boltzmann's two-fluid transport equations. The equations were solved by a digital computer for a plasma energy of $5 \times 10^6$ joules. The initial shape solution which resulted described a 16 cm diameter ball. Analysis of forces involved indicated that the initial shape should rapidly evolve into a stable configuration of a cylindrical plasma shell in the form of a torus. The toroidal diameter should be about 7.5 cm, with cylindrical diameter of 0.075 cm, and shell thickness of $8.3 \times 10^{-4}$ cm. The system would become unstable if the charged particle flow velocities became relativistic. There should be a strong external magnetic field produced by the ring current. The primary energy loss mechanism was found to be either bremsstrahlung or particle scattering, but it was not determined which mechanism was the more important. Use of the energy loss rates led to a time duration estimate of 20 minutes. This was sufficiently close to the maximum observed time of 15 minutes to be significant. The particles scattered out of the toroidal shell would be primarily electrons. These high energy electrons would form a dense beta particle field about the torus. The excitation and ionization in this field would produce a region of light about 15 cm in diameter with a power level of about 1000 watts. If the toroid were assumed to pass through a crack, the surrounding radiation field would be absorbed by the solid material forming the crack, and the radiation field would appear to shrink. A decrease in the energy of the beta particles scattered out of the toroidal shell would allow the toroidal structure of the ball lightning to be observed. It was concluded that all ball lightning characteristics in information available to the investigator could be explained by this model of a core ring and a unique enveloping radiation field, the use of ball lightning as a weapon would be greatly limited by inherent instabilities, and with the possible exceptions of lightning and aurora borealis, ball lightning is probably the most concentrated form of naturally occurring radiation which exists within a planetary atmosphere. (Dissertation Abstr., 23: No. 4, 1962)

**5519** LA MÉCANIQUE DES FLUIDES ET LA MAGNÉTOHYDRODYNAMIQUE. (Fluid Mechanics and Magnetohydrodynamics). Paris, Eyrolles, 1962. 173p.

The eight papers, together with the introductory address and discussions, presented to the Société Hydrotechnique de France on March 17, 1961, are compiled. The topics discussed are general theories of magnetohydrodynamics, particular theories for some magnetodynamic flows, and application of the magnetohydrodynamic principle to the production of electricity. Individual abstracts of the papers were prepared. (J.S.R.)

**5520** PLASMA PHYSICS AND MAGNETOHYDRODYNAMICS. D. Palumbo (Euratom, Brussels). p.15-26 of "La Mecanique des Fluides et la Magnetohydrodynamique." Paris, Eyrolles, 1962.

After a review of the characteristics of the plasmas which, it is hoped, can be utilized for the exploitation of thermonuclear reactions, the physical properties of such plasmas are examined in the light of the motion of individual particles and by a consideration of the fluid. Some analogies between magnetohydrodynamics, magnetohydrostatics, and classical hydrodynamics are discussed. Characteristic phenomena of the presence of the magnetic field and its effect on the behavior of the fluid are studied. (tr-auth)

**5521** STUDY OF THE STABILITY OF MAGNETOHYDRODYNAMIC EQUILIBRIA USING AN ENERGY PRINCIPLE. C. Mercier (Commissariat à l'Energie Atomique, Paris). p.27-37 of "La Mechanique des Fluides et la Magnetohydrodynamique." Paris, Eyrolles, 1962.

The stability of the equilibria of a magnetohydrodynamic system in which the velocity of the fluid is zero at each point is considered. After a solution of the equilibrium problem, the stability can be studied by "normal modes" or with an energy principle. In this second formulation, the instability of the system is bound to the possibility of finding a displacement which makes the sign of the potential energy negative. The consideration of the displacements located in the vicinity of particular surfaces with constant pressure permits a very severe stability criterion to be established with the use of this principle. Its results can be extended to plasmas with anisotropic pressure. (tr-auth)

**5522** HYPOTHESES AND BASIC EQUATIONS OF MAGNETOHYDRODYNAMICS. S. Colombo (Centre National de la Recherche Scientifique, Paris). p.39-44 of "La Mecanique des Fluides et la Magnetohydrodynamique." Paris, Eyrolles, 1962.

The equations of magnetohydrodynamics, used by physicists and engineers, result from the fusion made between the Euler-Navier equations and the Maxwell equations. However, the latter equations are invariant with respect to the transformations of the Lorentz group. This remark does not possess an essentially theoretical aspect because some hydromagnetic phenomena can be interpreted simply in the space-time of Minkowski, even when the fluid velocities remain small with respect to that of light. (tr-auth)

**5523** INTRODUCTION TO THE STUDY OF QUASI ONE-DIMENSIONAL FLOWS IN MAGNETOHYDRODYNAMICS. R. Mesrine (Departement Essais des Etudes at Recherches d'Electricite, France). p.45-61 of "La Mecanique des Fluides et la Magnetohydrodynamique." Paris, Eyrolles, 1962.

From the exact equations of a fluid medium in motion in a magnetic field, the one-dimensional form generally adopted for the description of "industrial" outflows, generator or accelerator, is justified. After a review of the three basic differential equations expressing conservations of mass, quantity of movement, and energy, these equations are transformed into integral invariants. The definition of mean values for each variable, in a transverse cross section of the flow, by introduction of particular coefficients permits a quasi one-dimensional formulation of motion to be found. A numerical application illustrates the utilization which can be made with the results obtained. (tr-auth)

**5524** PLANE FLOWS IN MAGNETOHYDRODYNAMICS. P. Caseau (Departement Essais des Etudes et Recherches d'Electricite, France). p.63-83 of "La Mecanique des Fluides et la Magnetohydrodynamique." Paris, Eyrolles, 1962.

Some general results on the theory of plane flows in perfect fluids are reported. As the results are truly interesting only in the framework of a linearization, the conditions under which this is possible are first defined. It is then seen that the theory of incompressible flows is particularly simple and rich in general results. It is extremely difficult to treat compressible flow in all generality. Only a limited case was treated in the present study, and flows were discovered, not evident a priori, which could be studied completely. (tr-auth)

**5525** TURBULENCE AND CHARGE LOSS IN CONDUCTING FLOWS IN CHANNELS WITH TRANSVERSE MAGNETIC FIELD. P. Engeldinger (Department Essais des Etudes et Recherches d'Electricite, France). p.85-120 of "La Mecanique des Fluides et la Magnetohydrodynamique." Paris, Eyrolles, 1962.

The principal results, both theoretical and experimental, on the charge flows, uniform and permanent, of conducting fluids exposed to a transverse magnetic field are reviewed. These results, which concern the velocity profiles in a section of the flow and the coefficients of regular charge losses, are first summarized in the case of the laminar regime. After a discussion of the stability factors affecting the establishment of turbulence, these same characteristics of flow are presented in the turbulent regime. (tr-auth)

**5526** THE MAGNETOHYDRODYNAMICS SEEN BY A MANUFACTURER. G. Klein (Compagnie Generale Electricite, France). p.121-33 of "La Mecanique des Fluides et la Magnetohydrodynamique." Paris, Eyrolles, 1962.

Some actual industrial applications of magnetohydrodynamics are reviewed. Future industrial applications based on the utilization of hot gases as conductors are discussed. The possibility of direct generation of electrical energy by magnetohydrodynamics is considered, and the principal technical problems to be resolved are described. The necessity of a better comprehension of the basic phenomena before extensive industrial exploitation is emphasized. (tr-auth)

**5527** SOME PRELIMINARY STUDIES WITH RESPECT TO THE MAGNETOHYDRODYNAMIC GENERATION OF ELECTRICAL ENERGY. J. Fabre and J. Pericart (Direction des Etudes et Recherches d'Electricite, France). p.135-56 of "La Mecanique des Fluides et la Magnetohydrodynamique." Paris, Eyrolles, 1962.

The principle of the procedure (expansion in a magnetic field of a high-temperature gas made sufficiently conducting by a convenient apparatus) is described. The admissible temperature limits are defined. The conductivity of the gas is determined, and expressions for the yield and power density are derived. The optimum shape for an acceptable yield is investigated. (tr-auth)

## Shielding

**5528** OPTIMIZED PROTECTION AGAINST ENVIRONMENTAL HAZARDS IN SPACE. E. N. Finkelman (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Aerospace Eng., 21: No. 12: 41-8(Dec. 1962).

The combined influences of micrometeoroids and solar flare radiation on manned lunar spacecraft design are analyzed. The minimum weight radiation protection will come from a shield which closely encloses the crew. The micrometeoroid protection that must be applied around the outside of the cabin pressure shell also provides radiation shielding. The general design of a radiation protection system is described using assumptions of the micrometeoroid and radiation environments that would be encountered on a lunar mission. Results show that high overall reliabilities for the combined protection system are difficult to achieve within practical weight limits. (H.D.R.)

**5529** SHIELD FOR IONIZING RADIATION. Jan V. Weinberger and August G. Luisada (to Gentex Corp.). U. S. Patent 3,065,351. Nov. 20, 1962.

A flexible radiation shield is described that was designed to conform to the contours of the human body. Containing lead amalgam, the shield is claimed to possess superior qualities of strength, structural stability, heat resistance, and shielding effectiveness. (R.J.S.)

## Theoretical Physics

**5530** (AFCRL-62-247) SOLUTION OF MAXWELL'S EQUATIONS IN A MAGNETO-IONIC MEDIUM WITH SOURCES. Scientific Report No. 4. R. Mittra (Illinois. Univ., Urbana. Engineering Experiment Station). Jan. 18, 1962. Contract AF19(604)-5565. 28p. (AD-274083)

Solutions of Maxwell's Equations with source terms are of considerable importance for many applications. A complete solution of the field equations is derived in a form which is suitable for the calculation of the fields of arbitrary distances from the source. For an infinitesimal dipole, the very near fields are found in a closed form involving trigonometric functions. The remainder of the solution is expressed in terms of a finite range integral, the integrand of which is finite everywhere. Hence, the solution is very suitable for numerical calculations. (auth)

**5531** (AFCRL-62-281) THE BOLTZMANN EQUATION AND NON-EQUILIBRIUM PHENOMENA IN IONIZED GASES IN ELECTROMAGNETIC FIELDS. Scientific Report No. 14(36). Joergen Bernhoft Knoff (Oslo. Universitetet. Institut for Teoretisk Astrofysikk.). 1961. Contract AF 61(052)-186. 93p. (AD-274055)

The non-equilibrium states (relaxation and transport) of ionized gases in electromagnetic fields are described from a very general basis (Liouville's equation). (auth)

**5532** (NP-12260) RELAXATION OF QUANTUM MECHANICAL SYSTEMS (thesis). Peter Mengert (Brandeis Univ., Waltham, Mass.). July 1962. 124p.

A general theory of relaxation was developed. The equation for the time-development of expectation values is shown to be equivalent to the density matrix equation of Bloch (except for a correction in sign of one term). Requirements for the validity of the equation were developed. The relaxation of a quantum oscillator was investigated in both the free and driven cases. An expression for the power absorbed when the oscillator is driven by an external field is given. Equations for multiple time correlation functions of relaxing system quantities are given and applied to a spin $^1/_2$ system. An analysis was set up for the relaxation of an oscillator in a case where memory effects can be included. (auth)

**5533** EQUATION FOR THE PROPAGATORS IN THE GAUGE COVARIANT FORMULATION OF QUANTUM ELECTRODYNAMICS. I. Białynicki-Birula (Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Math., Astron. Phys., 10: 381-3(1962). (In English)

Integral equations of Schwinger's type are derived for the propagators. The longitudinal part of the vertex function can be determined with the Ward identity and may be eliminated. It is shown that no gauge invariance-violating effects will appear. (D.L.C.)

**5534** CERTAIN EQUIVALENCE THEOREMS IN QUANTUM FIELD THEORY. I. Białynicki-Birula (Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 10: 385-90(1962). (In English)

The method of functional integration is used to prove various equivalence theorems in quantum field theory. Proof is presented for the equivalence of the Duffin-Kemmer formalism to the Klein-Gordon formalism and of the $\lambda\varphi^4$ theory to a certain theory with the cubic coupling. It is also shown how to obtain quantum electrodynamics from a field theory with the four-fermion interaction. (D.L.C.)

**5535** BOUNDARY CONDITIONS FOR ELECTROMAGNETIC FIELDS IN THE CASE OF MOVING MEDIA. A. Skorupski (Inst. of Nuclear Research, Polish Academy of Sciences, [Warsaw]). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 10: 391-5(1962). (In English)

The case of two continuous media moving arbitrarily is considered. Boundary conditions for electromagnetic fields on the surface separating the media are derived in a form invariant under Lorentz transformations as well as interpreted in terms of three dimensional notions. Transformation formulae for surface charges and currents are derived. (auth)

**5536** A PROOF OF THE UNICITY OF THE MASS-TENSOR OF NON-RELATIVISTIC HYDRODYNAMICS. Cz. Jankiewicz (Univ. of Wrocław, Poland). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 10: 397-402 (1962). (In Russian)

Two systems of equations are derived for the symmetric mass tensor of a physical system with field equations covariant in respect to Galilean transformations. The first of these systems results from the transforming properties of the tensor, while the second is due to the fact that the divergence of the tensor equals 0. It is shown—basing on the systems of equations obtained—that in non-relativistic hydrodynamics the symmetric mass tensor may be determined with an accuracy up to two arbitrary constants. (auth)

**5537** A PROOF OF UNIQUENESS OF THE ENERGY MOMENTUM TENSOR OF THE ELECTROMAGNETIC FIELD IN RIEMANNIAN SPACE. Ch. Jankiewicz (Univ. of Wrocław, Poland). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 10: 403-8(1962). (In Russian)

The uniqueness of the energy-momentum tensor of the electromagnetic field in an external gravitational field is considered. With the help of a tetrad field, the problem is reduced to its analogue in flat space and the results of Fock for the Minkowskian energy-momentum tensor are used. It is shown that the conservation laws $\nabla_\alpha T^{\alpha\beta} = 0$ determine the symmetric tensor $T^{\alpha\beta}$ up to two artibrary constants. (auth)

**5538** THE GRAVITON OF SPINS 2, 1, AND 0, PARTICLE ASSOCIATED WITH ASYMMETRIC GRAVITATIONAL FIELD INCLINING THE EFFECTS OF SPINS. Oliver Costa de Beauregard. Compt. Rend., 255: 1073-5(Aug. 6, 1962). (In French)

The graviton is coupled with the asymmetric inertial tensor of the Dirac field. A graviton of spin 1 coupled to the density of spin is added to the classical graviton of spins 2 and 0. (tr-auth)

**5539** THE GENERAL SOLUTION OF THE BOLTZMANN TRANSPORT EQUATION AND BOUNDARY-VALUE PROBLEMS. Hideo Suzuki (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: 1542-52(Oct. 1962).

The general solution of the linearized Boltzmann transport equation is derived for an infinite medium, a semi-infinite medium, and a medium bounded by two parallel planes. The particular solution required by the nature of the boundary scattering of the electrons is also obtained for these bounded media, subject to the following assumptions: a fraction p of the electrons arriving at the boundary of the medium is scattered specularly, while the rest are scattered diffusely; p is independent of the direction of motion of the electrons. The general solution of the linearized Boltzmann transport equation agrees completely with Chambers' expression, and the formulation presented by Mattis and Dresslhaus, Rodriguez, and Suzuki et al., all of whom have used the specular reflection boundary condition for the semi-infinite medium, is shown to be essentially correct. (auth)

**5540** STUDY OF A SYSTEM FORMED OF A LARGE NUMBER OF PARTICLES IN QUANTUM MECHANICS. Roger Balian and Vincent Gillet (Centre d'Études Nucléaires, Saclay, France). Nucleus (Paris), No. 4, 269-76 (July-Aug. 1962). (In French)

The problems presented by systems formed of a large number of particles are reviewed. The phenomena caused by interactions in such systems, the general problems which they pose, and the methods used for their resolution are discussed. (J.S.R.)

**5541** STOCHASTICALLY PERTURBED FIELDS, WITH APPLICATIONS TO WAVE PROPAGATION IN RANDOM MEDIA. R. C. Bourret (Hughes Research Labs., Malibu, Calif.). Nuovo cimento (10), 26: 1-31(Oct. 1, 1962). (In English)

The statistical properties of a classical field propagating through a randomly inhomogeneous medium are analyzed by a method in which the random medium is described by the two-point (bilocal) correlation function of its random characteristic, e.g., refractive index, potential, convective velocity, etc. A scheme of diagrams is introduced to classify the types of interaction between the propagating field and the random background. Equations for the one- and two-point fields are given, and the wave dispersion and attenuation they imply are discussed. The analysis is very similar to the Tamm-Dancoff theory of one- and two-nucleon propagators with virtual meson dressing and interaction, with the correlation function here playing the role of the meson field. A number of results obtained through the use of the method are described and various projected applications are cited. (auth)

**5542** ON CAUCHY'S PROBLEM IN GENERAL RELATIVITY. [PART] II. A. Peres (Princeton Univ., N. J.). Nuovo cimento (10), 26: 53-62(Oct. 1, 1962). (In English)

It is always possible to satisfy the three transverse constraints $\pi^{mn}_{.n} = 0$ by taking $\pi^{mn} = \delta S/\delta g_{mn}$, where S is any functional of the $g_{mn}$, invariant under co-ordinate transformations. If furthermore S is invariant under scale transformations, we also have $g_{mn}\pi^{mn} = 0$. The explicit construction of initial data for general relativity then reduces to the Lichnerowicz scalar equation, and can be achieved with arbitrary accuracy. This method can be considered as a first step towards a Hamilton-Jacobi formalism for the gravitational field. (auth)

**5543** UNITARITY AND THE EVALUATION OF DISCONTINUITIES. D. I. Olive (Cambridge Univ., [Eng.]). Nuovo cimento (10), 26: 73-102(Oct. 1, 1962). (In English)

If we call the connected part of the T-matrix element for the process b → a, $\mathcal{T}_{ab}$, then we prove the following result. If $\mathcal{T}_{ab}$ is the boundary value of an analytic function of complex invariants, then $\mathcal{T}^*_{ba}$ is an opposite boundary value. This follows directly from field theory, is independent of any special invariance principles, or of crossing symmetry and is not restricted to any type of process. This result achieves validity in a much wider context than was previously believed, and emerges as a fundamental consequence of the TCP theorem. It means that unitarity provides a direct evaluation of the corresponding discontinuity. (auth)

**5544** TRIANGLE INEQUALITIES FOR SPIN EFFECTS. R. J. N. Phillips (CERN, Geneva). Nuovo cimento (10), 26: 103-6(Oct. 1, 1962). (In English)

When the amplitudes for three reactions obey a triangle relation, because of charge independence or some other law, the three cross sections obey familiar inequalities. Further inequalities for the polarizations have recently been given. Inequalities are derived for more complicated spin effects, like depolarization and spin correlation, and their usefulness is discussed. (auth)

**5545** THE REDUCTION OF THE PRODUCT OF THREE 8-DIMENSIONAL REPRESENTATIONS OF U(3) AND SU(3) INTO IRREDUCIBLE REPRESENTATIONS. M. A. Rashid (Imperial Coll. of Science and Tech., London). Nuovo cimento (10), 26: 118-33(Oct. 1, 1962). (In English)

The reduction of the product of three 8-dimensional representations of U(3) and SU(3) into irreducible representations has been carried out. The reduction coefficients are presented as isoscalar factors. The results may be used for both Sakata and Ne'emann-Gell-Mann models of unitary symmetry of strong interactions. (auth)

**5546** A CONSISTENT OPERATOR SOLUTION FOR THE THIRRING MODEL. F. L. Scarf and J. Wess (Univ. of Washington, Seattle). Nuovo cimento (10), 26: 150-67 (Oct. 1, 1962). (In English)

The Thirring model is examined with the interacting currents redefined to be limits of non-local expressions, as proposed by Johnson. The most general solution to the new equation of motion is obtained as an operator functional of a canonical free field, its current, and the current of the interacting field. Since the latter also satisfies the free field wave equation, this is then an explicit solution for the interacting field operator. It is shown that this solution is completely consistent in the sense that the operator representative of a product is equal to the product of the operator representatives. The Hilbert space is defined, some renormalized matrix elements are calculated, and the results are compared with those obtained using the conventional, inconsistent formalism, and with Johnson's results. (auth)

**5547** ANALYTICITY AND UNITARITY OF GENERAL TRANSITION AMPLITUDES. A. J. Dragt and R. Karplus (Univ. of California, Berkeley). Nuovo cimento (10), 26: 168-76(Oct. 1, 1962). (In English)

The analyticity and unitarity hypotheses for a general transition amplitude are formulated carefully for a world containing only one type of particle. From these hypotheses follows the conclusion that the general transition amplitude has no singularities on the positive real energy axis other than isolated singularities at physical thresholds. The analytic behavior near each such singularity is exhibited. At thresholds for processes involving an odd number of particles, the behavior is logarithmic. (auth)

**5548** THE UNIQUENESS OF THE ANALYTIC CONTINUATION OF PARTIAL WAVE AMPLITUDE IN THE COMPLEX PLANE OF THE ANGULAR MOMENTUM. Hung Cheng and R. Núñez-Lagos (California Inst. of Tech., Pasadena). Nuovo cimento (10), 26: 177-81(Oct. 1, 1962). (In English)

The most general conditions on permissible analytic continuations of the partial wave amplitude are found. Conditions on the equality of two analytic continuations are also discussed. (auth)

**5549** ON CAUCHY'S PROBLEM IN GENERAL RELATIVITY. [PART] III. A. Peres (Syracuse Univ., N. Y.). Nuovo cimento (10), 26: 182-5(Oct. 1, 1962). (In English)

The Einstein gravitational equations are investigated in a co-ordinate system such that $g^{00} = 0$. It is convenient to consider the six $g^{mn}$ as the dynamical variables, while the $g^{0m}$ are three arbitrary functions of the co-ordinates, corresponding to the possibility of arbitrary 3-dimensional co-ordinate transformations. It is found that the four equations $G^{0\alpha} = 0$ do not contain any 0-derivatives of $g^{mn}$ and thus can be considered as initial constraints. On the other hand, the six equations $G^{mn} = 0$ do contain $g^{mn}_{,0}$ and $g^{mn}_{,0s}$ and describe the evolution of the field out of the initial hypersurface, when suitable boundary conditions are given. (auth)

**5550** CALCULATION OF REGGE POLES BY CONTINUED FRACTIONS. [PART] I. C. Lovelace and D. Masson (Imperial Coll. of Science and Tech., London). Nuovo cimento (10), 26: 472-84(Nov. 1, 1962). (In English)

Continued fractions for all the Regge poles of a wide class of potentials are obtained. They can be used to calculate the trajectories on an electronic computer. Graphs are shown of the first Regge trajectory for 20 Yukawa potentials. The method also gives a new way of calculating binding energies, which are obtained correct to 6 figures in many cases. (auth)

**5551** GENERAL RELATIVISTIC APPROACH TO THE POINCARÉ COMPENSATING STRESSES FOR THE CLASSICAL POINT ELECTRON. F. R. Tangherlini (Duke Univ., Durham, N. C.). Nuovo cimento (10), 26: 497-524(Nov. 1, 1962). (In English)

Solutions are obtained for the Poincaré compensating energy-stress tensor for the classical point electron. The tensor, denoted by $C^{\mu}_{\nu}$, may be chosen to cancel not only the divergent self-stress integral but the divergent Coulomb self-energy as well. The mass of the compensated electron may be provided for by superimposing the energy-stress tensor of a point mass (obtained recently as a source for the Schwarzschild field). The primary role played by general relativity in solving this problem is to provide a fundamental assumption as to the structure of $C^{\mu}_{\nu}$, in particular, for the static, spherically symmetric system of the point charge, it is assumed that energy density equals radial stress. This condition leads to an absence of gravitational self-energy and self-stress and an isomorphism between general relativity and special relativity for the tensors and equations needed to solve the Coulomb self-stress and self-energy problems. The condition also leads to a linearity of Einstein's field equations for the problem, which greatly simplifies the analysis. The compensated model of the electron would support an inertial origin of charge rather than an electromagnetic origin of mass. (auth)

**5552** ON THE ANALYTIC CONTINUATION OF THE S-MATRIX IN ANGULAR MOMENTUM. G. M. Prosperi (Univ. of California, Berkeley). Nuovo cimento (10), 26: 541-59(Nov. 1, 1962). (UCRL-10201). (In English)

It is proved that an analytic continuation of the coefficients of the partial-wave expansion for two-particle reactions, which M. Froissart proved was holomorphic up to the line Re $l = N$ ($N$ = number of subtractions in the Mandelstam representation), can be further continued up to the line Re $l = 1$, and it is meromorphic in this extended region. The result has been established for spinless particles of equal masses m, under the assumptions that the minimum threshold for the spectral functions (apart from single poles) is $4m^2$ and that there is an appropriate continuation in l of the factor of the inelasticity, and under certain other hypotheses about the number of zeros and the asymptotic behavior of the original Froissart continuation. The crossing symmetry and the unitarity condition in the three channels play an essential role in the proof. (auth)

**5553** THEORY OF SCATTERING ON HIGHLY SINGULAR POTENTIALS. N. Limić (Rudjer Bošković Inst., Zagreb). Nuovo cimento (10), 26: 581-96(Nov. 1, 1962). (In English)

It has been shown that potentials repulsive at the origin with a singularity higher than $1/x^2$ lead to the same analytic properties of the S matrix in the variable k as the potential with the finite first absolute momentum. There is a difference in the behavior of the S matrix for $k \rightarrow \infty$ in the k-plane and in the analyticity properties in the l-plane. In general the S matrix will have an essential singularity at the infinitely distant point of the k-plane and it is a meromorphic function of l. (auth)

**5554** REGGE TRAJECTORIES FOR THE SQUARE WELL POTENTIAL. C. G. Bollini and J. J. Giambiagi (Facultad de Ciencias Exactas, Buenos Aires). Nuovo cimento (10), 26: 619-21(Nov. 1, 1962). (In English)

The analytic expression of the S-matrix for the square-well potential was used to derive results for zero energy, behavior for small energies, large positive energies, and negative energy. (L.T.W.)

**5555** REGGE POLES AND THE VALIDITY OF THE ROSENBLUTH FORMULA. P. G. O. Freund (Université, Geneva). Nuovo cimento (10), 26: 633-4(Nov. 1, 1962). (In English)

Experimental observations on the differential e-p scattering cross section at high momentum transfers have recently led to questions on the validity of the Rosenbluth formula. Some experimental implications of a Reggelike behavior of the resonance that enhances the two-photon exchange are pointed out. (L.T.W.)

**5556** ON THE REMOVAL OF THE GHOST STATE IN THE LEE MODEL. G. Rasche and N. Straumann (Universität, Zurich). Nuovo Cimento (10), 26: 772-86(Nov. 16, 1962). (In English)

The elimination of ghost states, which has recently been carried out by Güttinger and Swieca with the help of an analytic continuation in the coupling constant using a perturbation method, is carried out for the Lee model exactly. The Lehmann representation for the propagator is enforced even for overcritical values of the coupling constant. The new theory can be reformulated in terms of a modified Hamiltonian, which contains a form factor even in the local limit. The new effective coupling constant cannot exceed a certain maximum value. That means that the removal of ghost states is only accomplished by a restriction to effectively weak coupling. (auth)

**5557** SIMPLE AND GENERALIZED CONDENSATION IN MANY-BOSON SYSTEMS. M. Girardeau (Univ. of Chicago). Phys. Fluids, 5: 1468-78(Nov. 1962).

The ground state of a system of interacting Bose particles is examined by a pair-correlation variational method based on exact eigenstates of the total particle number, without assuming macroscopic occupation of the single-particle state $k = 0$ ("simple" Bose condensation). Known results are recovered in the case of repulsive interactions of weak and intermediate strengths, where the ground state does in fact exhibit simple condensation. But it is shown that in the case of weak attractive interactions the ground state exhibits "generalized" condensation, in which a finite fraction of particles have momenta which are macroscopically negligible, but no one single-particle state is macroscopically occupied. A weak-coupling expansion is derived for the ground-state energy in this case, the leading term of which is three times as low as that of the state one would obtain in the case of simple condensation. By the use of a pseudopotential, this result is adapted to the case of a strongly interacting system with a small negative scattering length $\alpha$ and fixed low density $\rho$, giving $E_0/n = -(6\pi \hbar^2 \rho | \alpha | /m) [1-(128/45) \pi^{-1/2} (\rho | \alpha |^3)^{1/2} + \dots ]$. The relationships between equilibrium density, ground-state energy, and sound velocity predicted by this expression are in order-of-magnitude agreement with those obtaining for liquid $He^4$. (auth)

**5558** HIGHER BORN APPROXIMATIONS FOR THE COULOMB SCATTERING OF A SPINLESS PARTICLE. Ik-Ju Kang and Laurie M. Brown (Northwestern Univ., Evanston, Ill.). Phys. Rev., 128: 2828-32(Dec. 15, 1962).

The Coulomb scattering amplitude of a Klein-Gordon particle is computed exactly to the third order in $\beta = Ze^2/\hbar v$ by perturbation theory using the potential $Zee^{-\lambda r}/r$ in the limit $\lambda \to 0$. It contains only finite terms except for terms containing powers of $\ln(|Q|/\lambda)$ which can be shown to arise from the expansion of a common phase factor. Thus, first- and second-order corrections to the relativistic Rutherford cross section are obtained. The results are compared to the exact scattering amplitude in the form of the partial-wave summation, expanded in powers of $\beta$, which has been summed to third order. (auth)

**5559** CONSEQUENCES OF THE POSTULATE OF A COMPLETE COMMUTING SET OF OBSERVABLES IN QUANTUM ELECTRODYNAMICS. Frederik J. Belinfante (Purdue Univ., Lafayette, Ind.). Phys. Rev., 128: 2832-7 (Dec. 15, 1962).

It is shown that the radiation gauge (Coulomb gauge) of the potentials is the average of DeWitt's line-dependent gauge over all straight lines at constant time converging to the point where the potential is to be calculated. The radiation gauge is then used for demonstrating how the postulate of a complete commuting set of observables, contrary to Aharonov and Bohm's point of view, requires gauge-independent quantum electrodynamics rather than the use of the potentials of the Lorentz gauge. (auth)

**5560** COUPLING CONSTANTS AND UNSUBTRACTED DISPERSION RELATIONS. Richard H. Capps (Northwestern Univ., Evanston, Ill.). Phys. Rev., 128: 2842-50(Dec. 15, 1962).

It is argued that the common occurrence of low-energy resonances and the fact that the cross sections for strongly interacting particles seem to approach nonzero high-energy limits may be related to a physical principle which determines the values of the strong-interaction coupling constants. It is conjectured that, in some cases, these constants may be determined approximately by neglecting inelastic processes and requiring that certain of the low-angular-momentum phase shifts approach $\pm\pi/2$ at high energies. Such a calculation may be made by using unsubtracted dispersion relations for the inverse partial-wave amplitudes. This prescription is illustrated in a few simple models. Our present knowledge of the various pion-nucleon forces is insufficient for a realistic calculation of the pion-nucleon coupling constant $f^2$. However, a simple calculation involving drastic approximations predicts a value of $f^2$ close to the experimental value and a low-energy resonance in the (3,3) state. The relationship of our prescription to that of Albright and McGlinn is discussed briefly. (auth)

**5561** PERTURBATION THEORY OF MANY-BOSON SYSTEMS. A. J. Kromminga and M. Bolsterli (Univ. of Minnesota, Minneapolis). Phys. Rev., 128: 2887-97 (Dec. 15, 1962). (IS-451)

A noncanonical transformation of the boson creation and annihilation operators is performed in order to obtain a Hamiltonian which can be treated by the standard methods of field-theoretic perturbation theory. The standard results of Belyaev (with a slight modification) are rederived by this technique. (auth)

**5562** ANOMALOUS THRESHOLDS IN UNITARY THEORIES. J. C. Polkinghorne (Univ. of California, Berkeley). Phys. Rev., 128: 2898(Dec. 15, 1962). (UCRL-10363)

Consistency requirements for a Mandelstam representation are shown to imply identical anomalous threshold properties in perturbation theory and any unitary theory without the need to continue in external masses. (auth)

**5563** LEE MODEL WITH TWO V PARTICLES. P. K. Srivastava (Univ. of Chicago). Phys. Rev., 128: 2906-15 (Dec. 15, 1962). (EFINS-62-32)

For a relativistic field theory including two particles $V_i$ with the same quantum numbers described by Heisenberg fields $\psi_i(x)$, the values of the matrix elements $(0|\psi_i(x)|V_j)$ are obtained by the use of the asymptotic conditions. For a Lee model including two V particles these matrix-elements are used to obtain expressions for the renormalization constants. The consistency between the dispersion theoretic and Hamiltonian methods for this model is verified by discussions of several particular situations. (auth)

**5564** RELATIVISTIC CORRECTIONS IN THE STATISTICAL MECHANICS OF INTERACTING PARTICLES. John E. Krizan and Peter Havas (Lehigh Univ., Bethlehem, Penn.). Phys. Rev., 128: 2916-24(Dec. 15, 1962).

In previous work on statistical mechanics, the consequences of the theory of relativity have only been investigated for the ideal gas. This study is concerned with relativistic effects for systems of interacting particles. The noninstantaneous nature of the forces leads to dynamical equations which cannot be treated by known mathematical methods; however, the interaction terms can be expanded to obtain a description of the system in terms of the positions and their derivatives of all orders at a single time. If one stops at the $(v/c)^2$ approximation, a specification in terms of positions and velocities is obtained; in electrodynamics this corresponds to the Darwin Hamiltonian. A system described by this Hamiltonian is investigated with the methods of equilibrium statistical mechanics. The cluster expansion with subsequent summation of diagrams as employed by Mayer for the Coulomb case is used; the modifications necessary due to the presence of momentum-dependent terms in the interaction are developed. In evaluating the lowest order nonvanishing (ring) approximation, mathematical difficulties peculiar to the relativistic interactions force restriction to calculation of the relativistic short-range correlation effects in the charged system. A modified Debye-Hückel law is obtained, including a relativistic correction term which is small compared to the static one. At the high temperatures required for appearance of relativistic effects, the static term is itself negligible except at very high densities. Thus the relativistic contribution can in effect be neglected in this approximation. The difficulty of extending the method to mesonic or gravitational interactions is discussed. (auth)

**5565** AN ITERATION-VARIATION METHOD FOR ATOMIC SCATTERING PROBLEMS. H. E. Saraph and M. J. Seaton (University Coll., London). Proc. Phys. Soc. (London), 80: 1057-66(Nov. 1, 1962).

The solution of the integro-differential equations of atomic scattering theory is discussed. In previous work, approximate analytic solutions have been obtained using variational methods and numerical solutions have been obtained by iteration. It is known that rapid convergence may be obtained in an iteration-variation method in which the trial functions are linear combinations of the iterated functions. For scattering of slow electrons by hydrogen atoms the method gives four-figure accuracy with, at most two iterations, compared with eight iterations required in previous work. (autn)

**5566** THE COLLECTIVE TREATMENT OF MANY-BODY SYSTEMS. [PART] III. T. Gaskell (Univ. of Sheffield, Eng.). Proc. Phys. Soc. (London), 80: 1091-1100 (Nov. 1, 1962).

In a previous paper a trial wave function of the form $\Psi = D\Pi_{i<j}f(x_{ij})$ was used variationally to calculate the ground-state energy of an interacting electron gas, D being a determinant of plane waves and $f(x_{ij})$ a correlation function. In this work attention is focused on the nature of the wave function; in particular, the correlation function $f(x_{ij})$ and the pair distribution function are calculated and numerical results are presented for two widely different densities. In the course of this work, further light is thrown on the approximations made in the earlier energy calculations. Finally, the use of a wave function of the type $\Psi = \Pi_{i<j}f(x_{ij})$ in the calculation of the ground-state energy of a system of charged bosons is discussed and the exact high-density result of Foldy obtained. (auth)

**5567** ON HUBY'S RULES FOR NON-DEGENERATE RAYLEIGH-SCHRÖDINCER PERTURBATION THEORY IN ANY ORDER. B. Y. Tong (Univ. of Hong Kong, China). Proc. Phys. Soc. (London), 80: 1101-4(Nov. 1, 1962).

To supplement Huby's rules in the Rayleigh–Schrödinger perturbation theory of nondegenerate discrete levels, an expression for the total number of terms contained in the nth order is derived. The number of terms in the nth order having $\nu + 1$ disconnected factors is also found. (auth)

**5568** THE SPLITTING OF THE RIEMANN TENSOR. C. Lanczos (Dublin Inst. for Advanced Studies). Revs. Modern Phys., 34: 379-89(July 1962).

The antidual part of the Riemann tensor $R_{ijkm}$ in four dimensions has been studied by Rainich and Einstein. It is reducible to the contracted curvature tensor $R_{ik}$. The selfdual part of $R_{ijkm}$ is analyzed and reduced to a new tensor of third order $H_{ijk}$ of essentially 16 components. This tensor has the further property that it integrates the field equations of a quadratic action principle by reducing their order from 4 to 2. The relation of this tensor to Dirac's equation of the electron gives added proof of its fundamental significance. (auth)

**5569** AXIOMATIC S-MATRIX THEORY. Henry P. Stapp (Univ. of California, Berkeley). Revs. Modern Phys., 34: 390-4(July 1962). (UCRL-10052)

The general properties of the S matrix usually deduced from field theory can be derived from postulates expressing very general physical principles. This provides a basis for the establishment of S-matrix theory as an independent and self-contained framework for describing elementary-particle physics, a framework suited to the modern practical calculations in this field. (auth)

**5570** S-MATRIX THEORY OF STRONG INTERACTIONS WITHOUT ELEMENTARY PARTICLES. Geoffrey F. Chew (Univ. of California, Berkeley). Revs. Modern Phys., 34: 394-401(July 1962). (UCRL 10058)

S-matrix theory is reviewed. The postulates underlying the S-matrix theory of strong interactions are outlined, and the results of Froissart and Regge are given. The properties of Regge poles and the experimental status of the principle of maximum strength are discussed. Finally, the S-matrix theory is applied to high-energy scattering. (L.T.W.)

**5571** FIELD THEORIES WITH PERSISTENT ONE PARTICLE STATES. I. GENERAL FORMALISM. M. Dresden and Peter B. Kahn (State Univ. of Iowa, Iowa City). Revs. Modern Phys., 34: 401-29(July 1962).

**5572** CONFORMAL INVARIANCE IN PHYSICS. T. Fulton (Johns Hopkins Univ., Baltimore), F. Rohrlich, and L. Witten. Revs. Modern Phys., 34: 442-57(July 1962).

The conformal covariance of certain basic equations of modern physics is shown. This covariance is valid generally only when the requirement of constant rest masses is relaxed. It is necessary that all rest masses transform in a conformally covariant way. (L.T.W.)

**5573** THE NORMAL CONSTANTS OF MOTION IN QUANTUM MECHANICS TREATED BY PROJECTION TECHNIQUE. Per-Olov Loewdin (Univ. of Uppsala and Univ. of Florida, Gainesville). Revs. Modern Phys., 34: 520-30 (July 1962).

# REACTOR TECHNOLOGY

## General and Miscellaneous

**5574** (BLG-119) THE CHOICE OF THE OPERATIONAL PARAMETERS OF THE BR2 REACTOR. HOT SPOT FACTORS. G. Minsart and H. Dopchie (Brussels. Centre d'Étude de l'Énergie Nucléaire). Mar. 1962. 49p.

A study was conducted to establish a correlation between the parameters determining the operation level of the BR2 reactor. Calculations are based on preliminary measurements of neutron flux distribution in a core mockup facility, BR02, and the fuel element specifications. The limiting condition may be expressed as follows: maximum permissible plate temperature = water saturation temperature + superheat. The hot channel factor and hot spot factors are defined, and an estimate of the numerical value is given for each of them. (auth)

**5575** (BMI-1598) PROPERTIES OF FUELS FOR HIGH-TEMPERATURE REACTOR CONCEPTS. Roy W. Endebrock (Battelle Memorial Inst., Columbus, Ohio). Nov. 1, 1962. Contract W-7405-eng-92. 203p.

A compilation was prepared to aid design engineers in the selection of potential fuels for advanced high-temperature reactors. Available data are included on critical properties for all fuels believed to be potentially capable of operating at surface temperatures of at least 650°C. Fuels of recent interest with this capability are included even though sufficient data for their final evaluation are not yet available. The compilation is broken down into sections devoted to particular types of fuels. Property data for all these materials are arranged in a standardized format designed for rapid consultation. In addition to these data sheets, a master table that permits comparison of all fuels covered in the compilation on the basis of four properties considered essential in an initial fuel evaluation is presented. Also, a compilation of appropriate conversion units has been included for the design engineer's convenience. (J.R.D.)

**5576** (BNL-5985) CONVERSION RATIOS IN SLIGHTLY ENRICHED URANIUM, WATER MODERATED LATTICES. S. Tassan (Brookhaven National Lab., Upton, N. Y.). [nd.]. Contract [AT(30-2)-Gen-16]. 8p.

An experiment is described in which the conversion ratios were measured using highly enriched U-Al foils as catchers. Data are included on the ratios of epi-cadmium to sub-cadmium fission rates of $U^{235}$ in 1% enriched U light water moderated lattices, and on conversion ratios of 1% enriched U light water moderated lattices. (J.R.D.)

**5577** (GA-3523) INVESTIGATIONS OF CARBIDES AS CATHODES FOR THERMIONIC SPACE REACTORS. Final Report, May 15, 1961–August 31, 1962. A. F. Weinberg, R. G. Hudson, L. Yang, and F. D. Carpenter (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Contract NAS 5-1253. 160p.

The physicochemical properties of mixed carbides of U and Zr were measured to determine the usefulness of these materials as nuclear-heated thermionic emitters or as the nuclear fuel for refractory-metal thermionic cells. Property measurements of other carbide systems having potential as thermionic emitters were also performed. Vapor-loss data for mixed carbides were obtained in vacuum to determine the effects of temperature, time of exposure, U : Zr ratio, and specimen density. At 1988 to 2083°K, the rate of weight loss for specimens of nominal composition 90 mol-% UC-10 mol-% ZrC can be expressed as log $\dot{w} = 9.72 - 3.05 \times 10^4(1/T)$, where $\dot{w}$ is the rate of weight loss in mg/cm$^2$/sec and T is the absolute temperature. At 2130 to 2400°K, the rate of weight loss for specimens with compositions ranging from 14 mol-% UC–86 mol-% ZrC to 19 mol-% UC–81 mol-% ZrC can be expressed as log $\dot{w} = 8.30 - 3.03 \times 10^4(1/T)$. The introduction of a low-pressure (0.06 to 0.09 Torr) Cs-vapor environment was found to have no effect on the rate of weight loss. Studies were also conducted on the redistribution of the carbide components during long-time exposures and the relation of this redistribution to the rate of weight loss and the electron-emission characteristics. The rate of weight loss for a specimen of nominal composition 20 mol-% UC–80 mol-% HfC was determined at 2063° ± 11°K. Vacuum electron-emission measurements were made for a series of mixed carbides of varying U : Zr ratio. It was determined that these carbides behave as dispenser cathodes whose emission is not dependent upon the bulk U content. Methods of disturbing the U-metal monolayer on the specimen surface, which is requisite to good electron emission, were studied, as were methods of "reactivating" the layer after it had been removed. Electron emission from all of the carbides attained the useful level of 5 amp/cm$^2$ at temperatures below 2000°K. In this temperature range, the materials loss from specimens of high UC content would be less than 3 mils/yr and that from specimens of low UC content less than 1 mil/yr. Materials compatibility as related to the "marriage" of reactor fuels to refractory-metal thermionic emitters was studied. Four metals—W, Mo, Nb, and Ta were studied in combination with UC, UC$_2$, and UZrC at 1200 to 2000°C for times up to 1000 hr. The tests showed that only two of these materials combinations are compatible at temperatures to 1800°C: W with UC (or UZrC mixtures), and Mo with UZrC mixtures of low UC content. Barrier layers of Re, W–25 wt-% Re alloy, and ZrC were also investigated, with only ZrC proving effective for this application. To provide data for the engineering design of thermionic reactors using mixed carbides, measurements were also made of the electrical and thermal conductivities of these materials at temperatures up to reactor operating ranges. (auth)

**5578** (IDO-11002) ORGANIC COOLANT ESSENTIAL DATA FIFTH QUARTERLY REPORT, APRIL 1 TO JUNE 30, 1962. W. E. Ball, J. A. Ellard, C. D. King, M. V. Milnes, W. J. Moodie, and W. H. Yanko (Monsanto Research Corp. Dayton Labs., Ohio). July 12, 1962. Contract AT(10-1)-1088. 34p.

Determination of liquid and vapor viscosity and thermal conductivity properties of biphenyl was completed. The biphenyl heat transfer loop for liquid and vapor heat transfer, coolant decomposition, coolant deposition, erosion, and corrosion measurements at 700 to 850°F was put in operation. Various vapor properties of the isomeric terphenyls were calculated, and heat transfer runs with biphenyl at 700°F were made. Data on thermodynamic properties of biphenyl and isomeric terphenyls are included. (J.R.D.)

**5579** (NDA-2132-5) A STUDY OF WET STEAM AS A REACTOR COOLANT. Final Report, October 1, 1959–April 30, 1961. (United Nuclear Corp. Development Div., White Plains, N. Y.). Oct. 30, 1961. Work performed under United States-Euratom Joint Research and Development Program. Contract AT(30-1)-2303. 217p. (EURAEC-166)

In the course of a joint research and development program conducted by CISE, Ansaldo, and NDA, a conceptual design for a 300 Mw(e) direct cycle fog-cooled light water-moderated reactor was developed, indicating attractive economics (6.5 mills/kwh) and promising improved operational safety characteristics over boiling water systems. In addition, heat transfer data on wet steam in fog flow conditions obtained by CISE and others were examined analytically to develop an insight into the mechanism of burnout heat transfer under fog flow. The results of these studies suggest that the supply of liquid to the heated wall in the vicinity of the burnout region is mainly through diffusion of liquid droplets from the bulk of the stream, and that burnout predictions might be possible from formulations describing the rate of liquid cross flow based on a droplet diffusion model. (auth)

**5580** (NP-12239) SOVIET EXPERIMENTAL UF$_6$ REACTOR. Review of Soviet Literature AID Work Assignment No. 16. (Library of Congress. Aerospace Information Div., Washington, D. C.). Oct. 18, 1962. 12p. (AID-Report-62-172)

A description of a Soviet experimental reactor which uses gaseous UF$_6$ is presented. Included are general construction details, details of the control and safety systems, background information, and a discussion of the physics associated with the reactor. Photographs and diagrams of the reactor are included. (J.R.D.)

**5581** (NYO-10206) MULTI-GROUP DIFFUSION METHODS. K. F. Hansen (Massachusetts Inst. of Tech., Cambridge). Apr. 1962. Contract AT(30-1)-2344. 76p.

Multi-group diffusion methods of reactor analysis are discussed. The derivation of the multi-group equations from the age-diffusion equation and numerical methods of solving the equations are given. The adjoint function is introduced and the reasons for considering the adjoint are tested. The selection of numerical methods includes illustrations of various iterative methods. (auth)

**5582** ABSOLUTE MEASUREMENTS OF NEUTRON FLUXES IN WWS-REACTOR ACTIVATION REGION. Alexandru Stefănescu (Inst. of Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 71-7 (1962). (In Rumanian)

Absolute measurements of neutron fluxes by activation, using a device equipped with a front window Geiger-Mueller counter, achieved up to 10% accuracy. The absolute magnitude of thermal neutrons in a vibrating reactor channel was $(4.23 \pm 0.36) \times 10^{13}$ n/cm$^2$ sec. (R.V.J.)

**5583** CALCULATION OF FUEL TEMPERATURE INCREASE FOLLOWING A "LOSS OF COOLANT" ACCIDENT IN A NUCLEAR REACTOR. J. Tadmor, Y. Lehrer, and I. Pelah (Israel Atomic Energy Commission Labs., Rehovoth). Bull. Res. Council Israel, Sect. C, 11: 216-18 (July 1962). (In English)

A simplified and conservative method is described for the calculation of the fuel temperature rise following a "loss of coolant" accident in a nuclear reactor. The error in this computation is also evaluated. (auth)

**5584** TOWARDS THE SIMPLIFICATION OF REACTOR SAFETY. F. R. Farmer (United Kingdom Atomic Energy Authority, Risley, Eng.). J. Brit. Nucl. Energy Soc., 1: 295-306(Oct. 1962).

In new reactor systems, the safety analysis proceeds more slowly than the design, hindered by lack of information (either basic to the new system or related to incomplete design details) and perhaps by lack of effort. Safety measures are then superimposed—often at considerable expense—and sometimes strained unnaturally to fit the finished model. Much of this is initially inevitable but, as development is undertaken to give improved economy or reliability, so should safety provisions be developed as an integral part of the overall growth, and they should reduce and not increase in their extent. A simplification of safety measures is considered to be essential to maintain and improve safe operation. This simplification can be achieved if the objectives are sufficiently well defined and accepted by all groups who have a responsibility in this matter. This is not solely the responsibility of designers; others are involved, notably their safety advisers, operators, and the licensing authority. (auth)

**5585** NUCLEAR PHYSICS PROBLEMS OF WATER REACTORS. C. G. Campbell, J. Fell, and J. E. R. Holmes (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 1: 364-72(Oct. 1962).

The physics characteristics of water-type reactors are noted, and an outline is given of the theoretical methods and design models used in physics studies on these reactors. Attention is given to the analysis and behavior of the reactivity balance, temperature and void reactivity coefficients, reactivity control, spectral-shift control, power distributions, fuel cycles, and stability. (T.F.H.)

**5586** HEAT GENERATION AND TRANSFER IN A NUCLEAR REACTOR. D. MacDonald. J. Liverpool Eng. Soc., 7: 25-54(1961-62).

A mathematical analysis is presented covering build-up of matter, conversion of mass to energy, and modes of heat transfer. (R.J.S.)

**5587** COMMISSIONING BRADWELL NO. 1 REACTOR. A. R. Kirkpatrick (TNPG Commissioning Staff, Bradwell, Eng.). Nucl. Eng., 7: 470-7(Dec. 1962).

Experimental reactor physics began at Bradwell in August 1961, with the start of fuel loading on number 1 reactor. Experiences gained during the designing, planning, and execution of a suitable program are related. The program consisted mainly of making measurements during fuel loading and calibrating selected control rod and absorber patterns. The operations involved in setting the channel coolant flow restrictors were very much dependent on the results of the physics program. (W.D.M.)

**5588** ANALYSIS OF THE SODIUM REACTOR EXPERIMENT PROMPT POWER COEFFICIENT. C. W. Griffin (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 14: 304-11(Nov. 1962).

The prompt power coefficient resulting from the Doppler effect and fuel element bowing of unrestrained fuel clusters in the Th-U second core of the SRE was measured by performing power and flow ramp tests. Individual components of bowing magnitude and the Doppler coefficient were isolated. Fuel bowing resulted from three effects: axial temperature gradient, radial temperature gradient, and coolant flow. Magnitude of the flow effect was independent of power. Bowing was restrained by wrapping each cluster with a helically wound stainless steel wire. This reduced the power coefficient from +9¢/Mw to −2.5¢/Mw. The measured Doppler coefficient was −0.23¢/°F. (auth)

**5589** IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Harold Montague Finniston, Ronald Bryan Gibbon, and David George Rees (to C. A. Parsons and Co., Ltd.). British Patent 909,500. Oct. 31, 1962.

Fabrication of a reactor fuel element consisting of a solid bar of U coated with a Mg–Be film and bonded to a finned container of Mg alloy is described. (R.J.S.)

**5590** IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. David William Williams (to United Kingdom Atomic Energy Authority). British Patent 909,505. Oct. 31, 1962.

A sheathed reactor fuel element is provided with a zone containing a U–C alloy with at least 500 ppm of C. Preferential oxidation of this zone protects the remainder of the fuel element from oxidation. (R.J.S.)

**5591** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stefan George Bauer (to Rolls-Royce Ltd.). British Patent 909,637. Oct. 31, 1962.

A method for fabricating canned reactor fuel rods is described. The rod casing is produced by bending a strip of metal into a tubular form with the longitudinal edges adjacent and outwardly flanged. The tubular part is twisted about its longitudinal axis, thereby giving the flanged longitudinal edges a helical form. The flanges are welded together to form a tube having an external rib formed by the joined flanges. (R.J.S.)

**5592** IMPROVEMENTS IN OR RELATING TO POSITION INDICATING APPARATUS. Joseph Raymond Pendleton and Richard Smart (to United Kingdom Atomic Energy Authority). British Patent 909,848. Nov. 7, 1962.

An apparatus for nuclear reactors is described that will indicate the position of a movable member within a reactor containment shell from a point outside the shell. The apparatus consists of an energizing coil wound on a ferrous core outside the shell and a permanent magnet fixed to the movable member. (R.J.S.)

**5593** IMPROVEMENTS IN OR RELATING TO CHUTES, PARTICULARLY CHARGE CHUTES FOR NUCLEAR REACTORS. Ronald Bellinger and Stanley Charles Frederick Wills (to Strachan and Henshaw Ltd.). British Patent 909,862. Nov. 7, 1962.

A charge chute for nuclear reactors has been designed with a movable end portion that can be brought into register with a channel to be serviced, the channel not being concentric with the axis of the chute body. (R.J.S.)

**5594** A LINEAR MOTION DEVICE FOR OPERATING CONTROL RODS OF A NUCLEAR REACTOR. (to Societe Indatom). British Patent 910,203. Nov. 14, 1962.

A linear motion device has been designed that includes a longitudinally movable driven stem provided with racks formed with V-shaped teeth. Driving motors are equipped to engage and move the V-shaped teeth. (R.J.S.)

**5595** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Norman Bradley and Donald Wilfred Lawson (to United Kingdom Atomic Energy Authority). British Patent 910,299. Nov. 14, 1962.

A moderator structure for a nuclear reactor is described that is penetrated by a lattice of pressure-resisting reactor cooling tubes in which fuel elements can be located. Supports for pipes supplying coolant to the tubes are designed to relieve thermally induced stresses on the tubes and demountable joints between pipes and tubes. (R.J.S.)

**5596** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Norman Bradley (to United Kingdom Atomic Energy Authority). British Patent 910,300. Nov. 14, 1962.

Baffles are provided in the fuel element channels of steam-cooled reactors to allow for removal of condensate from the lower ends of the channels. A covering for collected condensate prevents entrainment with outflowing steam. (R.J.S.)

**5597** GRADIENT FUEL PLATES. (to U. S. Atomic Energy Commission). British Patent 910,366. Nov. 14, 1962.

A fuel plate for a flux trap reactor is described that is comprised of a clad fuel-bearing core of composite design. The primary core contains fissionable fuel and varies in thickness across its width. The secondary core, consisting of a burnable poison dispersed in a carrier material, covers at least one of the major surfaces of the primary core. (R.J.S.)

**5598** IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Kenneth Hogg (to C. A. Parsons and Co. Ltd.). British Patent 910,508. Nov. 14, 1962.

Ducts are provided for reactors suitable for passage of instruments through radiation shields. Shielded coffins are not necessary and disadvantages of serpentine ducts in the reactor shield are avoided. (R.J.S.)

**5599** IMPROVEMENTS IN OR RELATING TO COOLING SYSTEMS FOR NUCLEAR REACTORS. Roland Roche and Bernard Vrillon (to Commissariat à l'Energie Atomique). British Patent 910,564. Nov. 14, 1962.

An apparatus is described for distributing and collecting cooling fluid to and from channels of a heterogeneous nuclear reactor. The apparatus consists of two similar vessels, one on each side of the core, connected through the reactor channels. (R.J.S.)

**5600** IMPROVEMENTS IN THE PRECIPITATION OF FISSION DECAY PRODUCTS FROM GASES. David Gurney Arnold Thomas (to Dowty Electrics Ltd.). British Patent 910,644. Nov. 14, 1962.

An endless elongated conductor has been designed that is comprised of a number of plates, each having a conducting surface and secured in end-to-end relation by means of articulated joints. Fission products are precipitated from gases onto this conductor, which is then passed through a counting unit where the activity is measured. (R.J.S.)

**5601** IMPROVEMENTS IN OR RELATING TO SHOCK ABSORBING DEVICES FOR MOVING BODIES. Derek Boyd Jeffery (to General Electric Co., Ltd.). British Patent 910,713. Nov. 14, 1962.

A shock-absorbing device is described for moving bodies such as reactor shutdown rods. The device is comprised of a plastically deformable tube coiled upon a plunger member. Energy is dissipated when the coiled tube is deformed and frictionally engages the plunger. (R.J.S.)

**5602** METHOD OF PROCESSING POLYPHENYL NUCLEAR REACTOR COOLANT. Wayne E. Duffy (to North American Aviation, Inc.). U. S. Patent 3,062,728. Nov. 6, 1962.

A process is described for reforming polyphenyl degradation products into re-usable coolant fractions. It is shown that polyphenyl reactor coolants may be reconstituted by hydrogenating the high boiler degradation products at a temperature of about 250 to 575°C. (R.J.S.)

**5603** NUCLEAR REACTOR CONTROL SYSTEM. Kenneth A. Hub (to Internuclear Co.). U. S. Patent 3,065,162. Nov. 20, 1962.

A reactor control system is described that was designed for use in a closed cycle gas turbine power system. The control of reactor power level is coordinated with control of the heat transport capacity of the working fluid to accomplish a change in the work output capacity with a minimum amount of change in the working fluid temperature.

Fuel elements and other components are protected thereby from excessive temperatures and/or temperature variations. (R.J.S.)

**5604** MECHANICAL HANDLING APPARATUS FOR LOADING AND UNLOADING HETEROGENEOUS NUCLEAR FUEL REACTORS. David Reginald Davies (to Associated Electrical Industries (Manchester) Ltd.). U. S. Patent 3,066,089. "Priority date Sept. 12, 1956 Great Britain."

Apparatus is described for handling rod-type fuel elements arranged in vertical passages in the core. The loading structure is situated in the core chamber below the core and is rotatable about a vertical axis. (R.J.S.)

**5605** FUEL COMPOSITION FOR AQUEOUS HOMOGENOUS NUCLEAR REACTORS. Olle Lindstrom and Sven Hedman (to Allmanna Svenska Elektriska Aktiebolaget). U. S. Patent 3,067,121. "Priority date Oct. 25, 1958 Sweden."

Fuel compositions for aqueous homogeneous reactors are described that contain special substances which counteract adsorption of fissile material, fission products, and possible catalysts on the fertile material. An example of such a fuel composition is heavy water containing dissolved uranyl sulfate with a high content of active isotopes and dispersed thorium oxide. (R.J.S.)

## Power Reactors

**5606** (CVNA-156) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC., RESEARCH AND DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD APRIL–JUNE 1962. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Contract [AT (30-1)-2289]. 69p.

Research and development progress is reported on the Parr Shoals Power Reactor. Topics covered include: project administration, nuclear design, pressure tube assembly development and analysis, fuel development, irradiation experiments and analysis, materials development and fabrication techniques, and critical experiments. (M.C.G.)

**5607** (GEAP-3860) HIGH POWER DENSITY DEVELOPMENT PROJECT. INTERIM REPORT [ON] 300 MWe HPD CONCEPTUAL DESIGN STUDY. V. G. Grayhek (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 5, 1962. Contract AT(04-3)-361. 90p.

Work is being carried out on the conceptual design of a 300 Mw(e) high power density reactor. Core parameters, selection of core lattice, core support structure, lightweight core support structure, control rods, fuel, and fuel cycle cost estimates are described. Design analysis included: determination of stresses and deflections in the core support, thermal-hydraulic analysis of the reference core, statistical analysis of core hot-spot factors, and physics analysis of the reference core. (M.C.G.)

**5608** (HPR-27) OECD HALDEN REACTOR PROJECT. HBWR QUARTERLY PROGRESS REPORT, APRIL–JUNE 1962. (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). Sept. 1962. 58p.

Work was devoted to low-power experiments with the second fuel charge and preparation of the plant for operation at temperature. Control rod calibrations and measurements of temperature reactivity effects were carried out. During the period of high-temperature experiments unexpected power oscillations of two different categories occurred. One was found to be due to flashing void at the fuel element inlet nozzles and the other to fluctuating heavy water level in the reactor. A slight degradation of heavy water was experienced. (M.C.G.)

**5609** SELF-TESTING SAFETY SYSTEM MINIMIZES DOWNTIME OF POWER REACTORS. H. L. Hill and H. G. Pinder ([General Atomic Div., General Dynamics Corp., San Diego, Calif.]). Control Eng., 9: No. 5, 89-93(May 1962).

Many safety systems for nuclear power reactors have been designed to operate on the threshold of shutdown during most of the reactor uptime. This philosophy is evidenced by many plant histories of false shutdowns. A self-testing safety system incorporating component and function redundancy to provide both a high measure of safety and a high proportion of reactor uptime is described. (auth)

**5610** SUPPLIES OF ENRICHED URANIUM FOR NUCLEAR POWER PLANTS. Domenico Mosca. Ing. Nucl., 4: 227-35(Nov.-Dec. 1961). (In Italian)

On the basis of conditions applied currently by the USAEC, a summary is given of the principal data required for estimates on the U burnup, chemical reprocessing costs of irradiated fuel, and the value of the Pu produced. The two ways (lease and sale) in which $UF_6$ is made available by the USAEC are examined in conjunction with an economic comparison between lease and the special "deferred payment" sale applicable under the Euratom-US agreement for nuclear power plants. An appendix contains, together with a sample calculation for a reactor having a thermal power of 625 Mw, the economic factors used for determining the optimum quantity of fuel to be batched for shipping for chemical processing. (auth)

**5611** SOME TYPICAL PRESSURE VESSEL REACTOR DESIGNS. J. Smith (United Kingdom Atomic Energy Authority, Winfrith, Eng.) and M. C. Peters. J. Brit. Nucl. Energy Soc., 1: 327-42(Oct. 1962).

An outline is presented of the characteristics of several reactors that are in operational status and of the prospects for the development of some of the types of reactors represented (viz. pressurized water, boiling water, $H_2O/D_2O$ spectral-shift, and heavy water). The Shippingport, Yankee, Indian Point, Dresden, Humboldt Bay, BONUS, and Pathfinder reactors are described as examples. (T.F.H.)

**5612** PRESSURE TUBE REACTORS. N. Bradley (United Kingdom Atomic Energy Authority, Risley, Eng.). and W. Stanners. J. Brit. Nucl. Energy Soc., 1: 343-53 (Oct. 1962).

General aspects and common design features of pressure-tube reactors are outlined. Examples discussed include the Steam Generating Heavy Water Reactor (SGHWR), the CANDU reactor, and the Carolinas-Virginia Tube Reactor. (T.F.H.)

**5613** INITIAL PROBLEMS OF THE SUBMARINE PRESSURIZED WATER REACTOR DESIGN AND THE RELATED EXPERIMENTAL PROGRAMME. PART I. J. Edwards (Royal Naval Coll., Greenwich, Eng.). J. Roy. Naval Sci. Serv., 17: 127-41(1962).

The early work on the submarine pressurized-water reactor system carried out from 1955 to 1958 is described along with the problems encountered. Some of the items discussed include the organization of the development program, reactor physics problems, NEPTUNE zero-energy reactor, and shielding. (D.L.C.)

**5614** INITIAL PROBLEMS OF THE SUBMARINE PRESSURIZED WATER REACTOR DESIGN AND THE RELATED EXPERIMENTAL PROGRAMME. PART II. CHEMISTRY AND METALLURGY. J. Edwards (Royal Naval Coll., Greenwich, Eng.). J. Roy. Naval Sci. Serv., 17: 187-208(1962).

A review is presented of the problems appearing during the early years of the naval project. The experimental facilities and some of the results obtained are outlined. The work included development of fuel elements, control materials, structural materials, and water chemistry. The engineering aspects and the present status of the project are reviewed. (D.L.C.)

**5615** THERMODYNAMIC ADVANTAGES OF GASES AS POWER REACTOR COOLANTS. W. F. Banks (Space Technology Labs. Inc., Calif.). Nucl. Energy, 413-21(Nov. 1962).

Some of the thermodynamic fundamentals of power conversion as they affect the economics of central power stations are discussed. An evaluation is given of the relative potential of liquid-cooled and gas-cooled nuclear reactors for competing with the advanced coal-fired plants of the future. (auth)

**5616** SENSITIVITY OF NUCLEAR FUEL COSTS TO SELECTION OF COOLANT GAS. W. F. Banks. Nucl. Energy, 422-3(Nov. 1962).

The reasons for the expected high component of power cost associated with the fuel in the AGR are discussed in comparison with the EGCR fuel. The major differences between AGR and EGCR fuel assemblies are outlined. It is shown that the higher fuel costs of AGR are due to the choice of $CO_2$ rather than He as the coolant. A group discussion of other factors is given. (D.L.C.)

**5617** CAROLINAS-VIRGINIA PRESSURE TUBE REACTOR. Nucl. Energy, 424-7(Nov. 1962).

The 17-Mw(e) CVTR is a prototype for testing the concept of using pressure tubes to increase the reactor capacity without increasing the stresses in a single vessel. Some of the features and expected problems of CVTR are described. (D.L.C.)

**5618** A DIGITAL COMPUTER ANALYSIS OF LOSS-OF-COOLANT ACCIDENT FOR A MULTICIRCUIT CORE NUCLEAR POWER PLANT. Amir N. Nahavandi (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 14: 272-86(Nov. 1962).

A digital computer analysis of the loss-of-coolant accident in the primary system of a multi-circuit core nuclear power plant in the event of a complete severance of a pressure or jumper tube is presented. The time-dependent mass, momentum, and energy balance differential equations are expressed in finite difference form and solved numerically on an IBM-7090 digital computer together with the equations of state, system boundary conditions, and constraints. The system mass flow rate, pressure, and enthalpy distribution are calculated together with the other important system properties as functions of time during the transient operation following the break. The application of the analysis to the Carolinas-Virginia Tube Reactor indicates that the loss-of-coolant accident could lead to flow starvation in the reactor core and steam formation in the primary pump with subsequent core damage if no corrective action were taken. The flow starvation and steam formation problems are solved by the operation of a high pressure, high capacity emergency injection pump with fast starting characteristics. (auth)

**5619** DOUGLAS POINT NUCLEAR POWER STATION. Nuclear Power, 7: No. 77, 48(Sept. 1962).

A description is presented of various systems in the CANDU reactor. Performance data are outlined. The reactor, which is scheduled for completion in 1964, is a natural-U-fueled, $D_2O$-cooled and -moderated, pressure-tube reactor having an output of 200 Mwe. (T.F.H.)

**5620** CONTROL SYSTEM FOR HINKLEY POINT FUEL HANDLING. E. J. Bateman and P. J. Rawson (English Electric Co. Ltd., Whetstone, Leics, Eng.). Nuclear Power, 7: No. 77, 62-6(Sept. 1962).

The fuel loading rate of the Hinkley Point reactor is about 3 channels (24 elements) per day per reactor. A description is given of the automatic and semiautomatic fuel handling machinery, the control systems used in conjunction with this machinery, and the facilities provided (storage areas, transport devices, bottling and definning apparatus, etc.) in the handling system. (T.F.H.)

**5621** PROCEEDINGS OF THE AMERICAN POWER CONFERENCE, MARCH 27, 28, AND 29, 1962, CHICAGO, ILLINOIS. Proc. Am. Power Conf., 24: 1-1021(1962). $10.00.

Papers are presented on practical matters of interest to the power industry and associated groups. The technical, economic, and social aspects of generation, transmission, and utilization of power are discussed with emphasis on broad overall aspects rather than intricate technical details. Separate abstracts have been prepared for nine papers pertinent to nuclear power. (H.D.R.)

**5622** NUCLEAR HEAT SOURCES FOR MODERN STEAM TURBINES. J. H. Wright (Westinghouse Electric Corp., Pittsburgh). Proc. Am. Power Conf., 24: 183-94 (1962).

A brief review is presented of trends in modern turbine development and steam conditions since early 1900, and different types of reactor systems are reviewed for their capability of supplying the required steam to these modern turbines. One concept offering the potential for exceedingly large sizes and advanced steam conditions is the supercritical once-through tube reactor (SCOTT-R). The 1000 Mwe SCOTT-R design and development program is examined in detail and possible feasibility problems are discussed. (H.D.R.)

**5623** DEVELOPMENT OF GAS-COOLED REACTORS FOR LARGE HIGH-TEMPERATURE STEAM POWER PLANTS. D. W. ver Planck (General Atomics Div., General Dynamics Corp., San Diego, Calif.). Proc. Am. Power Conf., 24: 205-11(1962).

Progress is reported on the 40 Mwe prototype high-temperature, gas-cooled reactor (HTGR) now under construction at Peach Bottom, Pennsylvania. The fuel elements, control-rod system, and coolant-flow distribution are briefly discussed. Design, development, and economic considerations of large high-temperature, gas-cooled reactor power plants are concluded to be progressing at an encouraging rate. (H.D.R.)

**5624** IMPORTANCE OF HIGH POWER DENSITY BOILING-WATER REACTOR DEVELOPMENT TO WIDESPREAD ECONOMIC NUCLEAR POWER. D. H. Imhoff and S. Levy (General Electric Co., San Jose, Calif.). Proc. Am. Power Conf., 24: 212-20(1962).

The goals, economic advantages, and status of high power density development in boiling water reactors are discussed. The incentives and disadvantages of high power density development are compared, and it is concluded that the development will lead to reduced nuclear power costs. High power density operating experience will be acquired from the Big Rock Point Nuclear Plant now under construction. Several methods for improving care performance and other related developments are to be tested at the Big Rock Point facility. Data obtained from tests at the Vallecitos Boiling Water Reactor are discussed. (H.D.R.)

**5625** EFFECTS OF REACTOR CORE PARAMETERS ON PLANT COST. H. E. Vann (Jackson and Moreland, Inc., Boston). Proc. Am. Power Conf., 24: 221-31(1962).

A 300 Mwe pressurized water reactor plant was selected to illustrate the effects of variations in core parameters on power cost. The four significant parameters are found to be core power density, fuel specific power, metal volume fraction, and fuel exposure. These parameters are discussed in regard to their importance and interrelations, and conclusions are presented on effects of individual parameters on power costs. (H.D.R.)

**5626** SYMPOSIUM ON THE OPERATION AND PERFORMANCE OF THE DRESDEN NUCLEAR POWER STATION. Proc. Am. Power Conf., 24: 232-91(1962).

The plant layout, performance measurements, various aspects of operating experience, and modifications and inspection data are presented. Included are six papers entitled: Plant Description; Performance Measurements; Operation, Radiation Protection, and Maintenance; Power Generation Statistics, Load Schedules, and Water Chemistry; Reactor Performance and the Factors Affecting Economic Operation; and Modification and Inspection of Reactor Components. (H.D.R.)

**5627** A LIQUID METAL-HEATED FOSSIL FUEL-FIRED SUPERCRITICAL STEAM GENERATOR. R. W. Dickinson and D. F. Casey (Atomics International, Canoga, Park, Calif.). Proc. Am. Power Conf., 24: 329-37(1962).

The general design features of a 250 Mwe supercritical plant incorporating a liquid sodium heat transport system are presented. The reference design has been developed for oil and gas firing and can be easily extended to pulverized coal firing. Brief descriptions are given of the "two-fluid" system features and the reasons for their incorporation. Engineering and performance details of the reference design are included in an appendix. The system described appears to show 20 per cent less capital investment than a direct fired installation capable of the same performance. (H.D.R.)

**5628** WORKING FLUIDS FOR POWER GENERATION OF THE FUTURE. C. A. Meyer and F. K. Fischer (Westinghouse Electric Corp., Lester, Penna). Proc. Am. Power Conf., 24: 371-81(1962).

The development and limitations of the steam cycle as an efficient means of power generation is reviewed. Working fluids for the most economic power generation in the future are discussed along with the potential possibilities of new or unconventional power sources. The most promising new large-scale power source is determined to be the magnetohydrodynamic (MHD) cycle. No single material is listed that fits all the requirements for an advanced working fluid. The best possibilities for more economics, more efficient power generation appear to lie in the development of binary or tertiary fluid cycles to replace or supplement the steam cycle. (H.D.R.)

**5629** FEASIBILITY STUDY OF 300-MWE MHD POWER PLANT. R. C. Allen (Allis-Chalmers Mfg. Co., Milwaukee). Proc. Am. Power Conf., 24: 382-91(1962).

Component designs for a 300 Mwe magnetohydrodynamic (MHD) power plant are prepared and assembled into an overall plant complex. The plant is coal burning with air for combustion and the MHD generator operates in the peak temperature range. The MHD generator produces 80% of the gross electric output and a coupled conventional steam boiler generates the remaining 20% from steam power. Brief descriptions are given of the MHD generator, integrated MHD and steam generating plant cycle, combustion and air preheat system, d-c to a-c conversion system, operating cycle temperature-entropy diagram, heat rates and efficiencies, and the overall plant layout. Theoretical energy production costs show a substantial improvement over conventional steam plants. Future MHD applications and the major developmental problems to be solved are discussed. (H.D.R.)

**5630** NUCLEAR POWER ENGINEERING. M. M. El-Wakil, New York, McGraw-Hill Book Co., Inc., 1962. 568p. $15.00.

A study is made of reactor power plant engineering design and operation. An introduction is given to nuclear energy, atomic and nuclear reactions, atomic and molecular structure, and reactions involving neutrons. Consideration is also given to flux distributions in cores, time-dependent behavior, and thermodynamic and heat transfer aspects of nuclear power plants. Types of power reactors studied include boiling, pressurized-water, gas-cooled, organic-cooled and -moderated, liquid-metal-cooled, and fluid-fueled plants. (T.F.H.)

**5631** CIVILIAN NUCLEAR POWER. A Report to the President, 1962. (Atomic Energy Commission, Washington, D. C.). 73p. (Available from DTIE).

A review of the basic policies of AEC's nuclear power program is presented. Estimated future power needs are discussed and compared with the estimated fossil fuel resources. The possible benefits of nuclear power are also discussed, and it is concluded that the development of nuclear power is in the short- and long-term national interest. The present status of the nuclear power program is outlined. The different converter and breeder reactor types are described, and probable trends in the nuclear power industry are discussed. The need for nuclear power is assessed, and it is concluded that the nuclear power program should continue on an expeditious basis with added emphasis on stimulating industrial participation, on the power demonstration program, and on the development of breeders. The program for the immediate and long-range future is outlined, and the supporting technical programs are discussed. Finally, legal, financial, and administrative aspects of the program are discussed. (D.L.C.)

**5632** NUCLEAR STEAM GENERATOR. Robert U. Blaser (to Babcock and Wilcox Co.). U. S. Patent 3,066,088. "Application date Apr. 6, 1956."

A nuclear reactor steam generator has been developed for a pressurized water reactor. The steam generator is contained within a pressure vessel, the interior of which is divided into upper and lower chambers. The upper chamber has a steam outlet from which steam flows to a point of use. A body of water-cooled fissile fuel is arranged to fission in the lower chamber. Mechanical separating equipment receives the steam-water mixture from the lower chamber and delivers separated steam to the upper chamber. (R.J.S.)

## Research Reactors

**5633** EXPANSION OF EXPERIMENTAL SCOPE OF VVR-S REACTOR. Th. Rosescu and M. Săbau (Inst. of Nuclear Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 247-57(1962). (In Rumanian)

Theoretical and experimental data are given on the technical improvements designed for the experimental pressurized water reactor. The feasibility of changing reactor critical dimensions by varying reflector thicknesses and changing kinetic properties by varying neutron mean lives is discussed. An increase of local fluxes and production of variable spectra are also discussed, as well as the means for retaining a maximum sensitivity in measuring various perturbations. (tr-auth)

**5634** INITIAL OPERATION AND CHECKOUT OF THE AEG TEST REACTOR. G. Riesch (AEG-Kernenergieversuchsanlage Grosswelzheim über Aschaffenburg, Ger.). Kerntechnik, 4: 433-7(Oct. 1962). (In German)

A description is given of the first critical experiment with the AEG test reactor and of the subsequent checks of the properties of the reactor. Measurements were made of the shut-down reactivity, worth of the control rods, local dose rates, flux distributions, temperature coefficient, void coefficient, reactivity worth of samples, and the absolute thermal flux. (auth)

**5635** THE NEUTRON FLUX IN THE RADIATION POSITIONS OF THE MUNICH RESEARCH REACTOR (FRM). W. Koehler (Technische Hochschule, Munich). Kerntechnik, 4: 438-40(Oct. 1962). (In German)

Values for the thermal, epithermal, and fast neutron flux are given for positions in the current configuration of the Munich Research Reactor (FRM). The maximum thermal flux is $2.5 \times 10^{13}$ cm$^{-2}$ sec$^{-1}$ at a reactor capacity of 1 Mw, the maximum fast flux is $1.8 \times 10^{13}$ cm$^{-2}$ sec$^{-1}$. (auth)

**5636** THE DIDO-RESEARCH REACTOR AND ITS USE IN CONNECTION WITH THE BRITISH NUCLEAR POWER PROGRAMME. I. Everson and K. E. B. Jay (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Kerntechnik, 4: 459-61(Oct. 1962). (In German)

The importance of research reactors in the development of the British nuclear power program is discussed. Particularly important are experiments on the Wigner effect in graphite, the effects of irradiation on potential fuels and fuel elements, and the behavior of materials for fuel cans, moderators, and coolants. (P.C.H.)

# SPACE APPLICATIONS AND TECHNOLOGY

*Refer also to abstracts 4808 and 5577.*

**5637** (AD-275908) THERMIONIC CONVERTER RESEARCH. Report No. 3. Quarterly Progress Report No. 3, January 1, 1962–March 31, 1962. R. Laubenstein, W. Beyermann, and B. Chang (Marquardt Corp., Van Nuys, Calif.). Apr. 1962. Contract DA36-039 sc-87217. 37p.

Research on thermionic converters which are potentially capable of operation at temperatures obtained from the combustion of ordinary fossil fuels was continued. Measurements of the electrical resistivity of beta-eucryptite indicated that the relatively high resistivity may place severe restrictions on the design of an ion emission structure with a long operating lifetime. Arc mode operation of a cesium vapor thermionic diode with plane parallel molybdenum electrodes was obtained for emitter temperatures of 1300 to 1350°C. A power output density of 0.57 watt per $cm^2$ was obtained without optimizing all operating parameters. Negative emitter bias voltages of 0.2 to 0.5 volt were required to initiate the arc. (auth)

**5638** (AFCRL-62-148) OPTIMUM IMPURITY CONCENTRATION IN SEMICONDUCTOR THERMOELEMENTS. Scientific Report No. 6. Jose M. Borrego-Larralde (Massachusetts Inst. of Tech., Cambridge. Energy Conversion and Semiconductor Lab.). Jan. 15, 1962. Contract AF19(604)-4153. 125p. (AD-275052)

Research was carried out on the problem of obtaining the maximum efficiency of a thermoelectric generator. Expressions for the optimum current and maximum efficiency were obtained for the case of temperature-dependent parameters by using a first-order approximate solution to the heat-conduction equation. A figure of merit is defined for the case of temperature-dependent parameters. Equations were derived for the optimum carrier concentration, which yield a stationary value for the figure of merit. Conditions that are mathematically sufficient were obtained for the stationary value to be a maximum. Solutions of the equations for the optimum carrier concentrations are given for a nondegenerate extrinsic semiconductor. It was assumed that the lattice thermal conductivity and the carrier mobility were independent of the carrier concentration. The maximum figures of merit for both constant and variable carrier concentrations were compared. (auth)

**5639** (DCAS-TDR-62-32) ENERGY CONVERSION PROGRAM. MAGNETOHYDRODYNAMIC GENERATOR. Semiannual Technical Report, July 1–December 31, 1961. W. R. Grabowsky (Aerospace Corp., El Segundo, Calif.). Feb. 23, 1962. Contract AF04(647)-930. (AD-274644; TDR-930(2220-40)TR-1)

Material studies that will lead to the design and study of a magnetohydrodynamic vortex generator for use in a closed-cycle power conversion system were designed in detail, experimental facilities were constructed, and tests are being initiated. The tensile strength properties of tantalum, up to its melting point (3269°K), are being investigated. (auth)

**5640** (NASA-TN-D-1532) EXPERIMENTAL INVESTIGATION OF A 90° FLAT-PLATE MAGNETIC TRIODE FOR DIRECT ENERGY CONVERSION. Richard R. Cullom (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Nov. 1962. 13p.

An approach to decreasing the interelectrode space charge of a magnetic triode was tested by using a shaped magnetic field to improve triode performance. The shaped field was designed to restrict the electrons to circular orbits and thus to decrease electron-electron collisions and/or electron scattering. An improvement in the triode output power was observed with the shaped magnetic field. This improvement in the performance, however, was not of sufficient magnitude to make this particular triode a practical energy converter because the grid power loss was of greater magnitude than the power output. (auth)

**5641** (NP-12264) MAGNETOGASDYNAMIC THRUST VECTORING OF ROCKET MOTORS, INCLUDING THE EFFECTS OF FINITE ELECTRON-ION RECOMBINATION KINETICS. A Parametric Study. Daniel E. Rosner (AeroChem Research Labs., Inc., Princeton, N. J.). Feb. 1962. Contract NOw-60-0536-c. 75p. (AeroChem-TN-41)

Results of an investigation concerning the feasibility of using magnetic fields to control the motion of high-speed electrically conducting gases are presented. Such gases could be used, for example, in thrust vectoring jets in propulsion devices. The emphasis in the report is placed on presenting the results in a form having sufficient generality to be adaptable to various design needs. Independent aspects of the magnitude of the anticipated MHD effect for the case of conventional rocket motors in which expansion of combustion products is taking place are considered. Calculations for a number of propellant combinations are included. (J.R.D.)

**5642** (NP-12270) APPLIED RESEARCH ON A HERMETICALLY-SEALED DRIVE COUPLING FOR SPACE POWER TRANSMISSION. Second Quarterly Progress Report. (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). Nov. 1962. Contract AF33(657)-8486. 90p. (ER-5098)

A program to develop and demonstrate a one-to-one speed ratio hermetically sealed coupling for a 15 kw, 24,000 rpm space power unit and to provide a technical evaluation of the problems encountered in scaling the unit from 15 kw to 3 kw and 3000 kw is reported. The design requirements provide for power transmission through a continuous boundary with a device having a 90% over-all efficiency and 10,000 hours of maintenance free design life. Operating conditions will be 20 to 40 psi pressure differential, 1000°F K vapor on one side of the boundary, and $10^{-8}$ mm Hg vacuum on the opposite side. Progress during the past three months of the program includes completion of the magnetic coupling parametric analysis. The results indicate that a radial gap coupling with stationary electromagnetic sleeve is the most promising magnetic coupling concept. Other work reported includes design of the selected electromagnetic coupling, design of the high temperature K vapor and vacuum environment test rig, and design of the deformable membrane coupling. A test rig for the high-frequency evaluation of various bellows configurations was fabricated and is ready for the start of testing. (auth)

**5643** (UCRL-6553) HEAT-SHIELDED MAGNETICALLY CHANNELED PLASMA HEAT CONVERTER. Raymond Fox (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 5, 1961. Contract W-7405-eng-48. 27p.

A design for a thermionic converter is described which utilizes a permeable heat shield and a homogeneous magnetic field normal to the cathode and anode surfaces to minimize the radiant power loss without appreciably decreasing the electrical power output. The permeable heat shield consists of thin, close-spaced foils perpendicular to the cathode and anode surfaces. Radiant power transfer is expressed as a function of the spectral emissivities of the cathode and anode surfaces and the interfoil and interelectrode spacings. The heat shield is biased positive with respect to the cathode and anode surfaces to prevent positive ion loss, and, in conjunction with the normal homogeneous magnetic field, channels the electrons and ions to the anode. The required heat-shield positive bias is deduced and given as a function of the parameters of the converter. The energy conversion efficiencies attainable with this converter appear to be close to the Carnot efficiency. (auth)

**5644** (ZPh-084) SECONDARY ELECTRON EMISSION FROM SATELLITE SURFACES. D. B. Medved (General Dynamics/Convair, San Diego, Calif.). Mar. 17, 1961. Contract AF19(604)-5554. 37p. (AD-274799)

The relevance of secondary electron emission to the charge accumulation and production of electron sheaths around satellites is reviewed as a function of altitude and ambient conditions. It was found that for values of lambda greater than 0.0001, secondary electron emission can make an important contribution to these processes for altitudes below 250 km. Here lambda is the coefficient of secondary electron emission in terms of electrons emitted per incident neutral particle. If photoelectric processes are considered, then for quantum yields greater than 0.01 and photon fluxes greater than 1 microwatt/cm$^2$, satellite surface charge will go positive in an ambient ionized medium where the electron density is less than 1000. This corresponds to altitudes greater than 1000 km. (auth)

**5645** AN ELECTROSTATIC PROPULSION SYSTEM WITH A DIRECT NUCLEAR ELECTROGENERATOR. Charles A. Low, Jr. and William R. Mickelsen (National Aeronautics and Space Administration, Cleveland). Aerospace Eng., 21: No. 12, 58-9; 72-8; 80-1; 84-5; 87(Dec. 1962).

A preliminary study is presented to establish the theoretical feasibility of the direct nuclear electrostatic propulsion system and to provide an estimate of the possible mass/power ratio of an overall system. The general theory behind the direct nuclear electrogenerator and propulsion system is presented and various radioisotopes are evaluated for their suitability for space propulsion power. Electrogenerator cell design and energy losses are discussed. Two examples of 500 kw electrogenerator and propulsion system designs are examined in detail, one using Po-210 and the other Ce–Pr-144 as power source. Vehicle system performance is predicted for various missions using these two systems and a 500 kw Th-228 system. It is concluded that for certain applications the radioisotope direct electrogenerator and colloidal ion rocket system has possibilities of superior performance. This system is theoretically capable of making very fast interplanetary flights with greater payloads than other electric propulsion systems currently proposed or under development. (H.D.R.)

**5646** EVALUATION OF SPACE RADIATION DOSES RECEIVED WITHIN A TYPICAL SPACECRAFT. Andrew J. Beck and Edward L. Divita (Martin-Marietta Corp., Baltimore). ARS (Am. Rocket Soc.) J., 32: 1668-76(Nov. 1962).

An analysis of radiation levels that may be expected from the natural radiation environment is presented for (1) primary solar flare protons and protons contained in the inner Van Allen belt; (2) secondary radiation such as neutrons from (p,xn) nuclear reactions, gamma rays from (p,x$\gamma$) nuclear reactions, and protons from (p,xp′) nuclear reactions; and (3) electrons and electron-produced bremsstrahlung. The proton, neutron, and bremsstrahlung energy spectra and radiation doses are evaluated within aluminum spherical shells of various thicknesses for models of the proton fluxes from the May 10, 1959 and February 23, 1956 solar flares and protons contained in the inner Van Allen belt, as well as for models of the electron fluxes contained in the inner and outer Van Allen belts. Finally, these radiation quantities are evaluated within a typical spacecraft, considering its detailed material and equipment layout. (auth)

**5647** NEUTRALIZATION OF ION BEAMS FROM ENGINES OF ANNULAR GEOMETRY. J. W. Ward and R. A. Hubach (Huges Research Labs., Malibu, Calif.). ARS (Am. Rocket Soc.) J., 32: 1730-1(Nov. 1962).

It has been demonstrated experimentally under laboratory conditions that neutralization of an annular ion beam can be achieved by injection of electrons either within the engine or after the beam has been ejected from the engine. Pulse techniques were employed to compare neutralization achieved by two methods, and no significant differences were observed. (auth)

# WASTE DISPOSAL AND PROCESSING

*Refer also to abstract 4632.*

**5648** VERSATILE SCRUB TOWER REMOVES HALOGEN OFF-GASES. John Holmes (Argonne National Lab., Ill.). Chem. Eng., 68: No. 26, 94(Dec. 25, 1961).

A scrub system designed for the disposal of Cl, HCl, HF, and mixtures of the gases is presented. The off-gases react with anhydrous ammonia to form ammonium halide smoke, which is dissolved and removed by water spray. Analysis of the off-gas from the scrub tower showed efficiency to be nearly 100% in all tests. (P.C.H.)

**5649** AQUEOUS WASTE DISPOSAL IN ITALIAN NUCLEAR PLANTS. Guido Branca. Comit. Nazl. Energia Nucl., Notiziario, 8: No. 11, 53-66(Nov. 1962). (In Italian)

Italy's major achievements and programs in relation to the problem of contaminated liquid waste disposal are reviewed briefly. The aqueous waste disposal facilities at the Ispra Common Research Center, at the So.R.I.N. Nuclear Center of Saluggia, at C.N.E.N.'s Center for Nuclear Studies at Casaccia, at C.A.M.E.N.'s Nuclear Center of San Piero a Grado, at the C.I.S.E. Segrate Laboratory, at the Enrico Fermi Center for Nuclear Studies of the Milan Polytechnical School, and at the Garigliano, Latina, Trino Vercellese, and Organic Reactor Program power plants are discussed. (auth)

**5650** GLASSES SUITABLE FOR THE LONG-TERM STORAGE OF FISSION PRODUCTS. J. R. Grover and B. E. Chidley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Energy, Pt. A and B, 16: 405-21(Aug. 1962). (AERE-R-3178) (In English)

Glass compositions have been examined which are suitable for the incorporation of the highly active wastes from the processing of both uranium – aluminum alloy fuels and natural uranium fuels with a low burnup. Theoretical prediction of the effect of composition variables on the melting point and leach resistance has been confirmed experimentally. Samples of glass have been irradiated to a dose of $10^9$ rad without any deterioration of leach resistance. (auth)

**5651** DETERMINATION OF ACTIVITY IN RADIOACTIVE WASTE WATERS. U. O. Schanze. Städtehygiene, 12: 28-31(1961).

Methods and apparatus are described for the measurement of radioactivity in waste water, dealing with continuous measurements in flowing water, more accurate measurements made in evaporated and dried samples of waters or sludges, and portable apparatus for control measurements in tanks and pipes. Illustrations of the various types of apparatus are given and methods of standardization are briefly described. (Public Health Eng. Abstr., 42: No. 11, Nov. 1962)

**5652** TREATMENT OF RADIOACTIVE WASTE WATER. K. H. Rattay. Wasser Boden, 4: 115-17(1960). (In German)

Methods for treatment of radioactive waste water are discussed. Measurement problems are outlined. Topics covered include: collection, states of the radionuclides, precipitation, ion exchange, and evaporation. (M.C.G.)

**5653** THE LEACHABILITY OF RADIUM-226 FROM URANIUM MILL WASTE SOLIDS AND RIVER SEDIMENTS. Samuel David Shearer, Jr. Thesis, Madison, Wisc., Univ. of Wisconsin, 1962. 176p.

A study was made of the chemical and physical factors which influence the leaching of radium from uranium waste solids and river sediments. Various laboratory leaching tests were conducted on uranium waste solids and river sediments collected from representative locations in the Colorado Plateau area of the United States. Distilled water, inorganic reagents, and natural river waters were employed as leaching liquids. Distilled water leaching tests showed that the amount of radium leached from the solids studied is controlled primarily by the liquid-to-solid ratio (ml/gm). For a given quantity of waste solids from an acid leach uranium mill, with low volumes of leaching liquid, the amount of radium in solution is controlled by co-precipitation of radium with barium sulfate. At high liquid volumes as much as 50% of the radium can be leached. The amount of radium leached was found to be independent of time after about 15 minutes. The diffusion of radium from the interior to the surface of particles was found to be insignificant. This was true whether the solids were stored for a long time in a dry or wet environment. The results showed that the maximum amount of radium was leached in two consecutive leachings with subsequent leachings containing only a trace of dissolved radium. In addition, it was shown that the same total amount of radium was leached in a single leaching with barium chloride as was obtained in a series of consecutive leachings with distilled water followed by leaching with barium chloride. With the exception of barium chloride, leaching tests conducted with 0.01 M solutions of $HCl$, $NaCl$, $KCl$, $MgCl_2$, $CaCl_2$, $SrCl_2$, and $BaCl_2$ showed little effect on the amount of radium leached. Natural river waters showed no greater tendency to leach radium than distilled water, even though the chemical composition of the waters varied widely. Discussion is presented on the behavior of radium in a river following discharge of radium-bearing waste solids from a uranium mill. Recommendations are given for future work in this area. (Dissertation Abstr., 23: No. 4, 1962)

Th
an
fo
ci
in

ve
*N*
ar

"
co
ou
in

# CORPORATE AUTHOR INDEX

This index contains entries for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt." This change permits a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

## A

**AEROCHEM RESEARCH LABS., INC., PRINCETON, N. J.**
- Magnetogasdynamic thrust vectoring of rocket motors, 17: 5641 (NP-12264)

**AEROSPACE CORP., EL SEGUNDO, CALIF.**
- Modifying electrical properties of plasma sheath, 17: 5436 (DCAS-TDR-62-79)
- Prog. rpt. on energy conversion, 7–12/61, 17: 5639 (DCAS-TDR-62-32)
- Prog. rpt. on MHD turbulence, 7–12/61, 17: 5435 (DCAS-TDR-62-45)
- Structure of strong plasma shock waves in transverse magnetic field, 17: 5434 (DCAS-TDR-62-12)

**AKTIEBOLAGET ATOMENERGI, STUDSVIK, SWEDEN.**
- Resonance integral of Nb, 17: 5320 (AE-81)

**AMERICAN CYANAMID CO. CENTRAL RESEARCH DIV., STAMFORD, CONN.**
- Radiation grafting of chloromethylstyrene to polypropylene, 17: 4590 (TID-7643(p.345-97))

**AMERICAN CYANAMID CO. STAMFORD LABS., STAMFORD, CONN.**
- Radiation-induced ionic polymerization of butadiene, 17: 4575 (TID-7643(p.109-17))

**AMERICAN SOCIETY FOR TESTING MATERIALS, PHILADELPHIA.**
- Symposium on radiation effects, Atlantic City, 6/61, 17: 4893

**AMES LAB., AMES, IOWA.**
- Annual summary report 7/61–6/62, 17: 4444 (IS-500)
- Chemistry, 17: 4445 (IS-500(Sect.C))
- Engineering, 17: 4446 (IS-500(Sect.E))
- High-voltage trapezoidal pulse generator, 17: 4769 (IS-432)
- Metallurgy, 17: 4447 (IS-500(Sect.M))
- Physics, 17: 4448 (IS-500(Sect.P))
- Positron annihilation in solids, 17: 5200 (IS-299)
- Thermodynamic properties of La, Pr, Eu, Yb, and Y, 17: 4929 (IS-327)

**ARGONNE NATIONAL LAB., ILL.**
- Lattice constants of alpha U–Pu alloys, 17: 4923 (ANL-6460)
- Neutron radiography, 17: 4687 (ANL-FGF-378)
- Performance of Al–U alloy fuel plates, 17: 5023
- Plutonium fuel programs at Argonne, 17: 4887 (ANL-FGF-393)
- State nuclear technology, 1/62, 17: 4376 (TID-14912)

**ARMY CHEMICAL CORPS NUCLEAR DEFENSE LAB., ARMY CHEMICAL CENTER, MD.**
- Calibration of T(d,n)He$^4$ yield from positive ion accelerator, 17: 5412 (NDL-TM-6)

**ARMY NATICK LABS., NATICK, MASS**
- Irradiation "factor-dependency" of vinyl monomers, 17: 4571 (TID-7643 (p.1-16))

**ATOMICS INTERNATIONAL. DIV. OF NORTH AMERICAN AVIATION, INC., CANOGA PARK, CALIF.**
- Reprocessing irradiated UO$_2$ fuel, 17: 4628 (NAA-SR-7136)

**AVCO CORP. RESEARCH AND ADVANCED DEVELOPMENT DIV., WILMINGTON, MASS.**
- Vaporization and physical properties of refractories, 17: 4933 (WADD-TR-60-463(Pt.II))

## B

**BALLISTIC RESEARCH LABS., ABERDEEN PROVING GROUND, MD.**
- Neutron flux from point source in air, 17: 5294 (BRL-Memo-1432)
- Preliminary assignment of Si-28 excited states, 17: 5321 (BRL-Memo-1392)

**BATTELLE MEMORIAL INST., COLUMBUS, OHIO.**
- Grafting of vinyl pyrrolidone to polymethylmethacrylate by pre-irradiation techniques. 1., 17: 4580 (TID-7643(p.185-98))
- Properties of fuels for high-temperature reactor concepts, 17: 5575 (BMI-1598)
- Symposium on radiation-induced polymerization, BMI, 11/62, 17: 4570 (TID-7643)

**BIRMINGHAM. UNIV., ENGLAND.**
- Charged $\pi$ meson production in p-p collisions, 17: 5199 (AERE-R-3969)

**BOEING CO., SEATTLE.**
- Low frequency waves in hydromagnetic medium and geomagnetic micropulsations, 17: 5433 (D1-82-0150)

**BRANDEIS UNIV., WALTHAM, MASS.**
- Relaxation of quantum mechanical systems, 17: 5532 (NP-12260)

**BROOKHAVEN NATIONAL LAB., UPTON, N. Y.**
- Conversion ratios in slightly enriched U, H$_2$O-moderated lattices, 17: 5576 (BNL-5985)
- CSLO, Brookhaven decay curve analysis program, 17: 5411
- Decay of K$^+$, 17: 5202 (TID-14840)
- Diffusion cooling in graphite, 17: 5293 (BNL-5987)
- Gamma polymerization of ethylene, 17: 4574 (TID-7643(p.70-106))
- Measurement of Al-26 and Be-10 in meteorites, 17: 4717
- Radiation polymerization of acrylamide-propionamide, 17: 4577 (TID-7643(p.127-35))

**BROOKLYN. POLYTECHNIC INST.**
- Electron density profile, 17: 5439 (PIBMRI-987-62)

**BRUSSELS. CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE.**
- Operational parameters of BR2 reactor, 17: 5574 (BLG-119)
- Smakula's formula for F-center concentrations, 17: 5032 (BLG-123)

## C

**CALIFORNIA. UNIV., BERKELEY.**
- Macroscopic electrostatic and magnetostatic energy, 17: 5203 (UCRL-6499)

**CALIFORNIA. UNIV., BERKELEY. LAWRENCE RADIATION LAB.**
- Configuration interaction in rare earths, 17: 4498 (UCRL-10460)
- Matrix isolation studies of Group II chlorides, 17: 4497 (UCRL-10451)
- Metastable state of Ne atom under electron impact, 17: 5046 (UCRL-

10477)
Molecular-beam electric-resonance spectrometer and spectra of LiF, 17: 4499 (UCRL-10482)
Prog. rpt. on bio-organic chemistry, 6–8/62, 17: 4380 (UCRL-10479)
Prog. rpt. on bio-organic chemistry, 3–5/62, 17: 4561 (UCRL-10350)
Spontaneous fission of heaviest elements, 17: 5326 (UCRL-10474)

**CALIFORNIA. UNIV., LA JOLLA.**
Radiocarbon dating of deep water, 17: 4713

**CALIFORNIA. UNIV., LIVERMORE. LAWRENCE RADIATION LAB.**
Heat-shielded magnetically channeled plasma heat converter, 17: 5643 (UCRL-6553)
Inelastic scattering and Boltzmann equation, 17: 5205 (UCRL-6559-T)
Macroscopic electrostatic and magnetostatic energy, 17: 5203 (UCRL-6499)
Rocket for particulate sampling of clouds, 17: 4692 (UCRL-13054)
Thermodynamic cycling in magnetic pumping, 17: 5442 (UCRL-6355)
Uniqueness and rearrangement collisions, 17: 5204 (UCRL-6558-T)

**CANADA. DEPT. OF MINES AND TECHNICAL SURVEYS. MINES BRANCH.**
Radiation effects on p- and n-type catalysts, 17: 4569 (NP-12250)

**CARNEGIE INST. OF TECH., PITTSBURGH.**
Negative muon lifetimes in light isotopes, 17: 5324 (NYO-9286)
Reactions (p,xp) in 100 to 400-Mev region, 17: 5323 (NYO-8921)

**CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC., CHARLOTTE, N. C.**
Prog. rpt. on Parr Shoals Power Reactor, 4–6/62, 17: 5606 (CVNA-156)

**CATHOLIC UNIV. OF AMERICA, WASHINGTON, D. C.**
Prog. rpt. on reactor vibrational heat transfer, 5–7/62, 17: 4660 (CUA-NE-25)

**COLUMBIA UNIV., PALISADES, N. Y. LAMONT GEOLOGICAL OBSERVATORY.**
Variations in ratio $U^{234}/U^{238}$, 17: 4718

## D

**DENVER. UNIV. DENVER RESEARCH INST.**
Prog. rpt. on oxidation resistance of $NbAl_3$, 9/61–8/62, 17: 4902 (DRI-2061)
Prog. rpt. on oxidation resistance of $NbAl_3$, 9/62–11/62, 17: 4903 (DRI-2075)
Prog. rpt. on transition-metal hydryls, 6–9/62, 17: 4925 (DRI-2065)

**DEPARTMENT OF AGRICULTURE. SOUTHERN REGIONAL RESEARCH LAB., NEW ORLEANS.**
Radiation-induced graft polymers of cellulose, 17: 4588 (TID-7643(p.319-34))

**DOW CHEMICAL CO., MIDLAND, MICH.**
Graft copolymers of polyethylene and acrylic acid, 17: 4591 (TID-7643 (p.398-413))

**DOW CHEMICAL CO. ROCKY FLATS DIV., DENVER.**
Radioactive filter bank fire detection systems, 17: 4772 (RFP-253)

**DU PONT DE NEMOURS (E. I.) & CO. SAVANNAH RIVER LAB., AIKEN, S. C.**
Analytical techniques for control of T, 17: 4455 (DP-771)
Polarographic test for solvent quality. II., 17: 4456 (DP-772)
Tensile properties of Zy with oriented hydrides, 17: 4932 (TID-17372)

**DUKE UNIV., DURHAM, N. C.**
Final rpt. on thermodynamic properties of fused salts, 1962, 17: 4496 (TID-17367)

## E

**EUROPEAN ATOMIC ENERGY COMMUNITY.**
Nickel as diffusion barrier between U and Al, 17: 4926 (EUR-17.f)

## F

**FLORIDA. UNIV., GAINESVILLE.**
Two-stream instability, 17: 5441 (TID-17370)

**FRANCE. CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE. LABORATOIRE DE CHEMIE DES RADIATIONS, BELLEVUE.**
Radiation grafting, 17: 4582 (TID-7643(p.219-32))
Radiation-initiated polymerization in solid state, 17: 4578 (TID-7643 (p.136-49))

**FRANCE. COMMISSARIAT À L'ÉNERGIE ATOMIQUE, PARIS.**
Prog. rpt. on sintered $UO_2$, 1–3/62, 17: 4889 (EURAEC-322)
Sintering of $UO_2$, 17: 4621 (EURAEC-346)

**FRANCE. COMMISSARIAT À L'ÉNERGIE ATOMIQUE. CENTRE D'ÉTUDES NUCLÉAIRES, FONTENAY-AUX-ROSES.**
Thermal conductivity measurements at high temperatures, 17: 4774 (EURAEC-415)

**FRANCE. COMMISSARIAT À L'ÉNERGIE ATOMIQUE. CENTRE D'ÉTUDES NUCLÉAIRES, SACLAY.**
Analysis of "S" neutron-induced resonances, 17: 5295 (CEA-2156)
Lithium-6(d,$\alpha$)$\alpha$ reaction, 17: 5322 (NP-12258)

## G

**GENERAL ATOMIC DIV., GENERAL DYNAMICS CORP., SAN DIEGO, CALIF.**
Final rpt. on analysis of ionized gases, 7/62, 17: 4457 (GA-3358)
Final rpt. on carbides for thermionic space reactors, 5/15–8/31/62, 17: 5577 (GA-3523)
Summary of coated-particle-fuels development, 10/61–4/62, 17: 4888 (GA-3109)

**GENERAL DYNAMICS/CONVAIR, SAN DIEGO, CALIF.**
Secondary electron emission from satellite surfaces, 17: 5644 (ZPh-084)

**GENERAL ELECTRIC CO. AIRCRAFT NUCLEAR PROPULSION DEPT., CINCINNATI.**
A-C ionization chamber, 17: 4805 (DC-60-2-80)

**GENERAL ELECTRIC CO. ATOMIC POWER EQUIPMENT DEPT., SAN JOSE, CALIF.**
High Power Density development project, 17: 5607 (GEAP-3860)

**GENERAL ELECTRIC CO. HANFORD ATOMIC PRODUCTS OPERATION, RICHLAND, WASH.**
Air oxidation of U, 17: 4491 (HW-SA-2641)
Amines as extractants—organic phase, 17: 4626 (HW-SA-2797)
Band structure of $CaF_2$:Mn, 17: 5033 (HW-70230)
Materials of construction in fuels separations facilities, 17: 4627 (HW-SA-2810)
Neutral organophosphorus compounds as extractants, 17: 4559 (HW-SA-2796)
Quasi-elastic scattering by $H_2O$, 17: 5297 (HW-75147)
Radiation behavior of graphite materials, 17: 4990 (HW-SA-2814)
Radiation effects on carbons and graphites, 17: 4989 (HW-SA-2368)
Scintillating glasses for $\alpha$ counting, 17: 4806 (HW-SA-2191)
Solvent extraction studies at Hanford, 17: 4625 (HW-SA-2767)

**GENERAL ELECTRIC CO. VALLECITOS ATOMIC LAB., SAN JOSE, CALIF.**
Powder fuel processing, 17: 4909 (GEAP-3891)
Prog. rpt. on nuclear fuel burnup analyses, 6–9/62, 17: 4460 (GEAP-4082)

**GENERAL TELEPHONE AND ELECTRONICS LABS. INC., PALO ALTO, CALIF.**
Electron diffusion in multimode cavity, 17: 5042 (RADC-TDR-62-67)

**GEOLOGICAL SURVEY, WASHINGTON, D. C.**
Ammonia Tanks Quadrangle, Nevada, map, 17: 4732
Buckboard Mesa Quadrangle, Nevada, map, 17: 4730
Camp Desert Rock Quadrangle, Nevada, map, 17: 4721
Cane Spring Quadrangle, Nevada, map, 17: 4720
Frenchman Flat Quadrangle, Nevada, map, 17: 4719
Jackass Flats Quadrangle, Nevada, map, 17: 4729
Jangle Ridge Quadrangle, Nevada, map, 17: 4734
Lathrop Wells Quadrangle, Nevada, map, 17: 4726
Mercury Quadrangle, Nevada, map, 17: 4728
Mine Mountain Quadrangle, Nevada, map, 17: 4722
Oak Spring Quadrangle, Nevada, map, 17: 4739
Paiute Ridge Quadrangle, Nevada, map, 17: 4735
Plutonium Valley Quadrangle, Nevada, map, 17: 4736
Rainier Mesa Quadrangle, Nevada, map, 17: 4740
Rock salt deposits in the US, 17: 4705
Scrugham Peak Quadrangle, Nevada, map, 17: 4724
Skull Mountain Quadrangle, Nevada, map, 17: 4731
Specter Range NW Quadrangle, Nevada, map, 17: 4725
Striped Hills Quadrangle, Nevada, map, 17: 4723

Timber Mountain Quadrangle, Nevada, map, 17: 4738
Tippipah Spring Quadrangle, Nevada, map, 17: 4737
Topopah Spring NW Quadrangle, Nevada, map, 17: 4741
Yucca Flat Quadrangle, Nevada, map, 17: 4727
Yucca Lake Quadrangle, Nevada, map, 17: 4733

**GEOPHYSICS CORP. OF AMERICA, BEDFORD, MASS.**
Steadystate electron densities for irradiated plasmas, 17: 5437 (GCA-TR-62-8-A)

**GEORGIA INST. OF TECH., ATLANTA. ENGINEERING EXPERIMENT STATION.**
Final rpt. on high-temperature ceramic structures, 11/1/61–10/31/62, 17: 4931 (NP-12306)
Final rpt. on thermal precipitator, 5/15/59–5/15/62, 17: 4641 (TID-17378)
Prog. rpt. on radiation-induced cyanogenation of organic compounds, 7–9/62, 17: 4593 (TID-17266)

**GEOTECHNICAL CORP., GARLAND, TEX.**
Seismic measurements of Hebgen Lake earthquake, 17: 4691 (NP-12286)

**GOODYEAR ATOMIC CORP., PORTSMOUTH, OHIO.**
Analysis for U in Al alloy, 17: 4459 (GAT-T-1053)
Determination of lattice parameters, 17: 4490 (GAT-T-1052)
Lattice parameter of Si, 17: 4489 (GAT-T-1051)
Lattice parameter of W, 17: 4928 (GAT-T-998)
Precision of electron diffraction patterns, 17: 4458 (GAT-T-1050)

**GT. BRIT. NATIONAL INST. FOR RESEARCH IN NUCLEAR SCIENCE, HARWELL, BERKS, ENGLAND.**
Charged $\pi$ meson production in p-p collisions, 17: 5199 (AERE-R-3969)

## H

**HAHN-MEITNER-INSTITUT FÜR KERNFORSCHUNG BERLIN.**
Prog. rpt. on rare gas diffusion in solids, 7–9/61, 17: 4927 (EURAEC-312)

**HEBREW UNIV., JERUSALEM.**
Hyperfine interactions of Dy-160 in garnet, 17: 5031 (AFOSR-2535)
Paramagnetic resonance of rare earth ions, 17: 5030 (AFOSR-2114)

## I

**ILLINOIS INST. OF TECH., CHICAGO.**
Aromatic H exchange in methoxybenzenes, 17: 4560 (TID-17369)

**ILLINOIS INST. OF TECH., CHICAGO. ARMOUR RESEARCH FOUNDATION.**
Prog. rpt. on V alloys, 9/18–11/17/62, 17: 4924 (ARF-B231-7)

**ILLINOIS. UNIV., URBANA. ENGINEERING EXPERIMENT STATION.**
Maxwell's equations in magneto-ionic medium, 17: 5530 (AFCRL-62-247)

**ITALY. COMITATO NAZIONALE PER L'ENERGIA NUCLEARE, BOLOGNA.**
SOPHY—reactor design codes, 17: 4877 (CNEN-141)

## J

**JAPAN ATOMIC ENERGY RESEARCH INST., TOKYO.**
Bibliography on analytical chemistry of reactor fuels and materials, 17: 4461 (JAERI-4023)

**JAPANESE ASSN. FOR RADIATION RESEARCH ON POLYMERS. OSAKA LABS., OSAKA.**
Radiation-induced polymerization of ketene, 17: 4572 (TID-7643(p.28-55))
Radiation-induced polymerization of cyclic monomers, 17: 4579 (TID-7643(p.150-77))

**JOINT INST. FOR NUCLEAR RESEARCH, DUBNA, U.S.S.R.**
Renormalization of $\beta$ decay axial constant, 17: 5201 (JINR-P-1051)

## K

**KNOLLS ATOMIC POWER LAB., SCHENECTADY, N. Y.**
Applications of synthetic method, 17: 5303 (TID-15405)
Calculating fast few-group constants, 17: 5298 (KAPL-2220)
Microscopic self-shielding, 17: 5301 (TID-13710)
Solution of transport equation, 17: 5302 (TID-15404)

## L

**LIBRARY OF CONGRESS. AEROSPACE INFORMATION DIV., WASHINGTON, D. C.**
Soviet experimental UF$_6$ reactor, 17: 5580 (NP-12239)

**LOCKHEED MISSILES & SPACE CO., SUNNYVALE, CALIF.**
Radiation measurements with balloons, 1961, 17: 5163 (ARL-TDR-62-2)

**LONDON. UNIV. QUEEN MARY COLL.**
Diffusion and drift in F2 region, 17: 5029 (AFCRL-62-623)

**LOS ALAMOS SCIENTIFIC LAB., N. MEX.**
Bibliography on corrosion by liquid metals, 17: 4904 (LAMS-2779)
Empirical approach to anomalous dispersion, 17: 5045 (TID-14794)
Lifetime of neutrons in reflectors, 17: 5299 (LA-2743)
Programs for para-hydrogen properties, 17: 4493 (LAMS-2762)
Spark-discharge light source for time-resolved absorption spectroscopy, 17: 4773 (TID-14796)
Stability of plasma torus not dependent on azimuth, 17: 5440 (TID-13633)

**LOUVAIN, BELGIUM. UNIVERSITÉ.**
Measurement of Al-26 and Be-10 in meteorites, 17: 4717

## M

**MARQUARDT CORP., VAN NUYS, CALIF.**
Prog. rpt. on thermionic converter, 1–3/62, 17: 5637 (AD-275908)

**MASSACHUSETTS INST. OF TECH., CAMBRIDGE.**
Decay of K$^+$, 17: 5202 (TID-14840)
Final rpt. on thermoelectricity, 7/58–1/62, 17: 4885 (AD-274971)
Measuring plasma jet temperatures, 17: 5443 (WADD-TR-60-676(Pt.II))
Multi-group diffusion methods, 17: 5581 (NYO-10206)
Neutron dosimetry, spectrometry, and activation analysis, 17: 4807 (MITNE-8)
Prog. rpt. on energy conversion, 3/62, 17: 4886 (AD-275610)
Semiconductor thermoelements, 17: 5638 (AFCRL-62-148)
Thermal analysis of decomposition of Na carbonates, 17: 4495 (TID-13772)

**MASSACHUSETTS INST. OF TECH., CAMBRIDGE. LAB. FOR NUCLEAR SCIENCE.**
Thermal analysis of decomposition of Na carbonates, 17: 4495 (TID-13772)

**MASSACHUSETTS INST. OF TECH., LEXINGTON. LINCOLN LAB.**
Ferro- and antiferromagnetism in cubic cluster of spins, 17: 5027 (AD-273950)

**MAX-PLANCK-INSTITUT FÜR PHYSIK UND ASTROPHYSIK, MUNICH.**
Stability of plasma torus not dependent on azimuth, 17: 5440 (TID-13633)

**MOL, BELGIUM. CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE.**
Cold neutron sources. Programs in Europe, 17: 5296 (EANDC-22L)
Nickel as diffusion barrier between U and Al, 17: 4926 (EUR-17.f)

**MONSANTO RESEARCH CORP. DAYTON LABS., OHIO.**
Prog. rpt. on organic coolants, 4/1–5/30/62, 17: 5578 (IDO-11002)
Prog. rpt. on thermoelectric generator, 1/1–3/30/62, 17: 4638 (AD-274164)

**MOUND LAB., MIAMISBURG, OHIO.**
Prog. rpt., 1/62, 17: 4374 (MLM-1129)
Prog. rpt., 2/62, 17: 4375 (MLM-1133)

## N

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.**
Scanning mechanism for x-ray spectrometer, 17: 4808 (NASA-TN-D-1097)

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND.**
Magnetic triode for direct energy conversion, 17: 5640 (NASA-TN-D-1532)

**NATIONAL RESEARCH COUNCIL. MATERIALS ADVISORY BOARD.**
Prog. rpt. on casting and powder metallurgy, 9/62, 17: 4910 (MAB-139-M(C7))

**NAVAL POSTGRADUATE SCHOOL, MONTEREY, CALIF.**
Modifying electrical properties of plasma sheath, 17: 5436 (DCAS-TDR-62-79)

**NAVAL RESEARCH LAB., WASHINGTON, D. C.**
J-values of s-type neutron resonances. III., 17: 5300 (NRL-5851)

**NEW HAMPSHIRE. UNIV., DURHAM.**
Asymptotic directions of primary cosmic protons, 17: 5179 (AFCRL-62-453)

**NEW MEXICO STATE UNIV., UNIVERSITY PARK.**
Bremsstrahlung emission and electric conductivity in plasma, 17: 5429 (AD-275288)

**NEW MEXICO. UNIV., ALBUQUERQUE.**
Bibliographies on isotopic exchange reactions, 17: 4494 (SCR-512)
Differential topology and algebraic structures, 10/62, 17: 4878 (TID-17355)

**NEW YORK OPERATIONS OFFICE. HEALTH AND SAFETY LAB., AEC.**
Multiplication factors for bare cylinders, 17: 5198 (HASL-124)

**NEW ZEALAND. DOMINION X-RAY AND RADIUM LAB., CHRISTCHURCH.**
Prog. rpt. on fallout in New Zealand, 4–6/62, 17: 4690 (DXRL-F5)

**NORTH CAROLINA STATE COLL., RALEIGH.**
Textile fiber modification by radiation-induced graft polymerization. I., 17: 4586 (TID-7643(p.268-99))
Textile fiber modification by radiation-induced graft polymerization. II., 17: 4587 (TID-7643(p.300-18))

**NORTHEASTERN UNIV., BOSTON.**
Decay of $K^+$, 17: 5202 (TID-14840)

**NORTHWESTERN UNIV., EVANSTON, ILL.**
Decay of free radicals in irradiated polyethylene, 17: 4581 (TID-7643 (p.200-18))

**NORWAY. INSTITUTT FOR ATOMENERGI. OECD HALDEN REAKTOR PROSJEKT.**
Prog. rpt. on Halden reactor, 4–6/62, 17: 5608 (HPR-27)

**NUCLEAR METALS, INC., CONCORD, MASS.**
Al–Li phase diagram, 17: 4930 (NMI-7010)
Prog. rpt. on dies for extrusion of steels and refractory alloys, 6/15/62–9/15/62, 17: 4911 (NMI-9700.3)

## O

**OAK RIDGE NATIONAL LAB., TENN.**
Aerodynamic-thermodynamic study of centrifugal compressors, 17: 4639 (ORNL-3294)
Annual prog. rpt. on solid state physics, 8/62, 17: 5035 (ORNL-3364)
Collimator study for 5-Gev electron beam, 17: 5413 (ORNL-TM-423)
Crystal physics, 17: 5037 (ORNL-3364(p.27-56))
Metals, 17: 5038 (ORNL-3364(p.57-84))
MHD stability of vortex flow, 17: 4661 (ORNL-TM-402)
Nonmetals, 17: 5039 (ORNL-3364(p.85-124))
Prog. rpt. on brazing ceramics, 11/62, 17: 4912 (ORNL-TM-413)
Radiation metallurgy, 17: 5040 (ORNL-3364(p.125-50))
Radiation safety and control manual, 17: 4744 (TID-7027)
Reactor materials, 17: 5041 (ORNL-3364(p.151-200))
Safety of Oak Ridge Critical Experiments Facility, 17: 4742 (ORNL-TM-349)
Scintillation process in CaI(Tl), 17: 5034 (ORNL-3354)
Smear techniques for surface monitoring for radioactive materials, 17: 4743 (ORNL-TM-435)
Solid state theory, 17: 5036 (ORNL-3364(p.1-26))

**OHIO STATE UNIV. RESEARCH FOUNDATION, COLUMBUS.**
EM parameters for hypersonic plasma sheath, 17: 5430 (AD-276418)

**OSLO. UNIVERSITETET.**
Ionized gases in electromagnetic fields, 17: 5531 (AFCRL-62-281)

## P

**PENNSYLVANIA STATE UNIV., UNIVERSITY PARK.**
Interplanetary magnetic field and auroral zones, 17: 5028 (AFCRL-62-423)

**PHILLIPS PETROLEUM CO. ATOMIC ENERGY DIV., IDAHO FALLS, IDAHO.**
Thermal decomposition of hydrated Fe, Cr, and Ni nitrates, 17: 4492 (IDO-14597)

**PITTSBURGH. UNIV.**
Applications of nuclear quadrupole resonance, 17: 4443 (AFOSR-2542)

**PRINCETON UNIV., N. J.**
Equilibrium and stability for systems with small curvature, 17: 5438 (MATT-89)
Nonlinear coupled oscillators. I., 17: 4770 (MATT-95)
Positron decay of Sc-42, V-46, Mn-50, Co-54, and Cu-58, 17: 5325 (PUC-1962-62)

## R

**RADIATION APPLICATIONS INC., LONG ISLAND CITY, N. Y.**
Radiation crosslinking of polymers, 17: 4584 (TID-7643(p.245-58))
Radiation-induced graft polymerization, 17: 4583 (TID-7643(p.233-44))

**RAND CORP., SANTA MONICA, CALIF.**
Production of polar auroras and electrojets, 17: 5043 (RM-3058-NASA)
Radio wave absorption due to electron-ion collisions, 17: 5044 (RM-3391-PR)

**RCA VICTOR CO., LTD. RESEARCH LABS., MONTREAL.**
Solid state charged particle Si detectors, 17: 4804 (ARL-62-406)

**RESEARCH TRIANGLE INST., DURHAM, N. C.**
Radiation-induced grafting to cellulose, 17: 4585 (TID-7643(p.259-67))

**RIO DE JANEIRO. CENTRO BRASILEIRO DE PESQUISAS FÍSICAS.**
Lithium-6(d,$\alpha$)$\alpha$ reaction, 17: 5322 (NP-12258)

**ROCKETDYNE DIV., NORTH AMERICAN AVIATION, INC., CANOGA PARK, CALIF.**
Final prog. rpt. on compatibility of materials with K, 4/60–12/61, 17: 4905 (NP-12334)

## S

**SANDIA CORP., ALBUQUERQUE, N. MEX.**
Bibliographies on isotopic exchange reactions, 17: 4494 (SCR-512)
Differential topology and algebraic structures, 10/62, 17: 4878 (TID-17355)
Radiation-induced reactions of methylene blue in aqueous solutions, 17: 4592 (TID-14927)

**SHELL DEVELOPMENT CO., EMERYVILLE, CALIF.**
Radiation-induced polymerization of $\alpha$-olefins, 17: 4573 (TID-7643(p.56-69))

**STANFORD RESEARCH INST., MENLO PARK, CALIF.**
Final rpt. on interaction of EM waves with plasma, 4/62, 17: 5431 (AFCRL-62-185)

## T

**TAPCO. DIV. OF THOMPSON RAMO WOOLDRIDGE INC., CLEVELAND.**
Prog. rpt. on coupling for space power transmission, 8–10/62, 17: 5642 (NP-12270)

**TENNESSEE. UNIV., KNOXVILLE.**
Radiation-induced polymerization of cyclopentadiene, 17: 4576 (TID-7643(p.118-26))

## U

**UNION CARBIDE NUCLEAR CO. Y-12 PLANT, OAK RIDGE, TENN.**
Tests of proposed U container, 17: 4745 (Y-KB-22)

**UNITED KINGDOM ATOMIC ENERGY AUTHORITY. RESEARCH GROUP. ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, BERKS, ENGLAND.**
Charged $\pi$ meson production in p-p collisions, 17: 5199 (AERE-R-3969)

**UNITED KINGDOM ATOMIC ENERGY AUTHORITY. WEAPONS GROUP. ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKS, ENGLAND.**
Range of electron densities in transient plasmas, 17: 5432 (AWRE-O-14/62)

**UNITED NUCLEAR CORP. DEVELOPMENT DIV., WHITE PLAINS, N. Y.**
Final rpt. on wet steam as reactor coolant, 10/1/59–4/30/61, 17: 5579 (NDA-2132-5)

**UNITED STATES–EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.**
Final rpt. on wet steam as reactor coolant, 10/1/59–4/30/61, 17: 5579 (NDA-2132-5)
Prog. rpt. on rare gas diffusion in solids, 7–9/61, 17: 4927 (EURAEC-312)

Prog. rpt. on sintered $UO_2$, 1–3/62, 17: 4889 (EURAEC-322)
Thermal conductivity measurements at high temperatures, 17: 4774 (EURAEC-415)

**UNITED STATES NAVAL ACADEMY, ANNAPOLIS, MD.**
Liquid scintillation system for interactions of high-energy muons with heavy nuclei, 17: 4809 (NP-12248)

## W

**WASHINGTON STATE UNIV., PULLMAN.**
Electrical breakdown in vacuum, 17: 4640 (TID-15465)

**WEST VIRGINIA. UNIV., MORGANTOWN.**
Preparation of wood–plastic combinations using radiation, 17: 4589 (TID-7643(p.335-44))

**WESTINGHOUSE ELECTRIC CORP. ATOMIC POWER DIV., PITTSBURGH.**
Prog. rpt. on Parr Shoals Power Reactor, 4–6/62, 17: 5606 (CVNA-156)

**WESTINGHOUSE ELECTRIC CORP. BETTIS ATOMIC POWER LAB., PITTSBURGH.**
Transformations between half-range and full-range angular expansions, 17: 5206 (WAPD-T-1305)

## Z

**ZIMNEY CORP., MONROVIA, CALIF.**
Rocket for particulate sampling of clouds, 17: 4692 (UCRL-13054)

# PERSONAL AUTHOR INDEX

Each entry after an author's name is a shortened version of the title of the report or article, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt." This change permits a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä becomes ae
ö oe
ø oe
ü ue (except in transliterated Chinese names)

## A

**ABAMOVICH, M. I.,** Photoproduction of $\pi^+$ mesons, 17: 5287
**ABRAGAM, Anatole,** Production of beam of polarized particles, 17: 5076
**ABRAHAM, F. F.,** Proton-proton collisions at 19.8 Bev/c, 17: 5236
**ABSON, Wilfred,** Condenser chamber dosimeters, 17: 4862
**ACHTELLIK, Gerald J.,** Radiation meter, 17: 4867
**ACKER, Terese Ellen,** Radiation-induced graft polymerization, 17: 4583 (TID-7643(p.233-44))
**ADAMS, J. A. S.,** Distribution of Th in Mancos shale, 17: 4696
**ADAMS, J. A. S.,** Distribution of Th in weathering profile, 17: 4697
**ADLER, G.,** Radiation polymerization of acrylamide-propionamide, 17: 4577 (TID-7643(p.127-35))
**ADLER, George,** Gamma polymerization of ethylene, 17: 4574 (TID-7643 (p.70-106))
**AGARWAL, S. P.,** Spatial distribution of cosmic ray intensity, 17: 5192
**AITKEN, E. A.,** Sintering in radiation environment, 17: 4899
**AKASHI, Makoto,** Photoprotons from Al, 17: 5340
**ALBENESIUS, Edward L.,** Analytical techniques for control of T, 17: 4455 (DP-771)
**ALBERIGI-QUARANTA, A.,** Photoproduction of muon pairs in C, 17: 5260
**ALBERT, P.,** Radioactivation analysis of Al, Fe, and Zr, 17: 4480
**ALBERTI, G.,** Separation of inorganic ions by electrophoresis, 17: 4467
**ALBRIDGE, R. G.,** Internal conversion in I-132 decay, 17: 5371
**ALEXANDER, Guy B.,** Dispersion-strengthened Ni alloy, 17: 4967
**ALIMOVA, I. A.,** Exchange between Li–K, Li–Na, and Li–Ca, 17: 4635
**ALLEN, R. C.,** Feasibility study of 300-Mwe MHD power plant, 17: 5629
**ALMAGRO, J.,** Reversible and irreversible processes in dropping Hg electrode. XIII., 17: 4507
**ALMAGRO, V.,** Reversible and irreversible processes in dropping Hg electrode. XIII., 17: 4507
**ALMETER, F. M.,** Surface damage in Be, 17: 4937
**ALSUP, Elsie Beth,** Radiation effects on flour protein, 17: 4766
**AMAI, Saburo,** Observation in quantum mechanics, 17: 5152
**AMALDI, Ugo, Jr.,** Nucleon-nucleon diffraction scattering, 17: 5243
**ANBAR, M.,** Applications of I-132 in thyroid studies, 17: 4386
**ANBAR, M.,** Neutron reaction in fluoroorganic compounds, 17: 4603
**ANDERS, Fred J., Jr.,** Dispersion-strengthened Ni alloy, 17: 4967
**ANDERSON, Ernest C.,** Gamma rays in space, Ranger 3, 17: 5185
**ANDERSON, K. A.,** Solar flare x-ray burst, 17: 5091
**ANDREWS, J. R.,** Radiation effect on mammalian tumor cells, 17: 4411
**ANELLIS, A.,** Resistance of *Clostridium botulinum* to $\gamma$ rays, 17: 4394
**ANNO, J. N.,** Energy spectrum of fission fragments from $UO_2$, 17: 5085
**ANNO, James N., Jr.,** Triode concept of direct conversion, 17: 5068
**ANTONOV-ROMANOVSKII, V. V.,** Flash mechanism of SrS phosphors, 17: 5049 (UCRL-Trans-853(L))
**APALIN, V. F.,** Neutron emitted by U-236 in symmetric fission region, 17: 5351
**APEL, John R.,** Effects of trapped particles on geomagnetic field, 17: 4704
**APPA RAO, M. V. K.,** Tritons and deuterons in primary cosmic radiation, 17: 5189
**APPLEGATE, Kenneth R.,** Bibliographies on isotopic exchange reactions, 17: 4494 (SCR-512)
**ARAI, S.,** ESR of electron-irradiated cycloheptatriene, 17: 4604
**ARCIPIANI, Biagio,** Measurement of the U-238 Cd ratio, 17: 5373
**ARMBRUSTER, P.,** Chain lengths for decay of U-235 fission products, 17: 5407
**ARMSTRONG, Arthur A., Jr.,** Textile fiber modification radiation-induced graft polymerization. I., 17: 4586 (TID-7643(p.268-99))
**ARMSTRONG, Arthur A., Jr.,** Textile fiber modification radiation-induced graft polymerization. II., 17: 4587 (TID-7643(p.300-18))
**ARMSTRONG, D. S.,** Electromagnetic pumps for liquid metals, 17: 4643
**ARNOLD, D. S.,** Drying and calcining of raffinate, 17: 4630
**ARNOLD, James R.,** Gamma rays in space, Ranger 3, 17: 5185
**ARNOLD, James R.,** Nuclear effects of cosmic rays in meteorites, 17: 5060
**ARNOLD, R. C.,** Vector mesons and KN, $\bar{K}N$ interactions, 17: 5246
**ARNOLDY, R. L.,** Van Allen outer radiation regions, 17: 5184
**ARTHUR, Jett C., Jr.,** Effects of $\gamma$ radiation on cotton. IV., 17: 5021
**ARTHUR, Jett C., Jr.,** Radiation-induced graft polymers of cellulose, 17: 4588 (TID-7643(p.319-34))
**ASHBURN, Edward V.,** Changes in earth magnetic field from high-altitude explosion, 7/9/62, 17: 5106
**ASKARIAN, G. A.,** Reflection of radiation from moving plasma, 17: 5513
**ASUNDI, R. K.,** Band spectrum of CuCl molecule. IV., 17: 5070
**AUCOUTURIER, Marc,** Structure heredity between $\beta$ and $\alpha$ phases of Co, 17: 4948
**AUERBACH, Irving,** Radiation-induced reactions of methylene blue in aqueous solutions, 17: 4592 (TID-14927)
**AUERBACH, Leonard B.,** Pion-pion interactions, 17: 5252
**AUER-WELSBACH, Helga,** Pyrophorous alloys, 17: 4935 (AEC-tr-5545)
**AULT, R. G.,** Prog. rpt. on thermoelectric generator, 1/1–3/30/62, 17: 4638 (AD-274164)
**AURICCHIO, Ferdinando,** Sodium pump in human erythrocytes, 17: 4412
**AUSTIN, A. E.,** Irradiation damage in UC, 17: 4900
**AZZONI, P.,** SOPHY—reactor design codes, 17: 4877 (CNEN-141)

## B

**BABICKY, Arnost,** Calcium metabolism after x irradiation. III., 17: 4425
**BACIU, G.,** Triggering and adjustments of betatron, 17: 5414
**BAEV, A. K.,** Evaporation in the KCl, LnCl, (La, Ce, Pr, Nd), 17: 5284

**BAICKER, Joseph A.**, Radiation-induced changes in Si cells, 17: 4995
**BAILY, W. E.**, Steam sintering of UO$_2$, 17: 4913
**BAIN, A. S.**, Central melting in UO$_2$ fuels, 17: 4895
**BAIRD, James C.**, Oxygen-17 hyperfine structure, 17: 4533
**BAKER, H. R.**, Properties of Ce and Fe compounds, 17: 4450
**BAKER, Kay D.**, Plasma frequency probe, 17: 5078
**BAKER, M.**, Similarities of weak, strong, and electromagnetic interactions, 17: 5238
**BAKER, R. C.**, Magnetic disturbance from nuclear explosion, 17: 5104
**BAKER, W. F.**, Elastic p-p cross sections, 17: 5258
**BAKER, William R.**, Production of hot rotating plasma, 17: 5492
**BALDESCHWIELER, John D.**, Preliminary assignment of Si-28 excited states, 17: 5321 (BRL-Memo-1392)
**BALDWIN, David E.**, Close collisions in plasma, 17: 5498
**BALDWIN, W. H.**, Interactions between TBP, H$_3$PO$_4$, and water, 17: 4454
**BALESCU, R.**, Irreversible processes in gases, 17: 5074
**BALIAN, Roger**, System of large number of particles, 17: 5540
**BALL, W. E.**, Prog. rpt. on organic coolants, 4/1–5/30/62, 17: 5578 (IDO-11002)
**BALLOU, N. E.**, Nuclear debris in sea water, 17: 4750
**BANKS, Charles V.**, Oxidized complex of Ni, 17: 4506
**BANKS, W. F.**, Gases as power reactor coolants, 17: 5615
**BANKS, W. F.**, Nuclear fuel costs, 17: 5616
**BAPTISTA, A. M.**, Oxidation yield in Fricke dosimetry of P-32 $\beta$ radiation, 17: 4597
**BARASHNEV, Yu. I.**, Radiation injuries associated with treatment of tumors, 17: 4400
**BARBER, R. C.**, Separation energies for isotopes of Sn and Sb, 17: 5333
**BARDEEN, John**, Tunneling into superconductors, 17: 5138
**BARNES, R.G.**, Resonance of Cl-35 in FeCl$_3$, 17: 4537
**BARONCELLI, F.**, Amine extraction of HNO$_3$, 17: 4453
**BARRALL, Edward M., II**, Thermal analysis of decomposition of N carbonates, 17: 4495 (TID-13772)
**BARRON, Randall F.**, Superconductivity. II., 17: 4647
**BARTHOLOMEW, G. A.**, Neutron-capture $\gamma$ rays, 17: 5058
**BARTHOMEUF, D.**, Neutron activation analysis of Na, 17: 4482
**BARTLETT, A. A.**, Double-focusing $\beta$ spectrometer and performance, 17: 4844
**BARTLETT, Alan C.**, Radiation effects on reproduction in *T. castaneum* Herbst, 17: 4417
**BASHANDY, E.**, Half life of 152-kev transition in W-182, 17: 5394
**BASSANI, F.**, Screening correction to Slater exchange potential, 17: 5147
**BASSEL, R. H.**, Inelastic scattering of $\alpha$ particles. I., 17: 5382
**BASSHAM, J. A.**, Path of C in photosynthesis, 17: 4390
**BATEMAN, E. J.**, Hinkley Point fuel handling, 17: 5620
**BATEMAN, J. L.**, Dose-rate dependence of early radiation effects, 17: 4421
**BATTLE, Norman**, Improvements in control valves, 17: 4658
**BATTY, C. J.**, Bulk ionization semiconductor detectors, 17: 4837
**BAUER, Stefan George**, Improvements in or relating to power plant, 17: 4755
**BAUER, Stefan George**, Improvements in control valves, 17: 4658
**BAUER, Stefan George**, Improvements in nuclear reactors, 17: 5591
**BAUMINGER, R.**, Hyperfine interactions of Dy-160 in garnet, 17: 5031 (AFOSR-2535)
**BEAN, C. P.**, Superconductors as permanent magnets, 17: 5084
**BEARD, David B.**, Boundary between magnetic field and plasma, 17: 5454
**BEARD, David 3.**, Geomagnetic field, solar wind interface, 17: 5174
**BECK, Andrew J.**, Space radiation doses in spacecraft, 17: 5646
**BECK, Richard L.**, Properties of ZrH$_2$, 17: 4940
**BECK, Richard L.**, Zirconium–hydrogen phase system, 17: 4939
**BECKER, E. W.**, Chemical method of isotope separation, 17: 4872 (AEC-tr-5527)
**BECKER, E. W.**, Enrichment of C-13, 17: 4871 (AEC-tr-5526)
**BECKERS, J.**, Matrix $\beta_4$ relative to theory of spin-1 particles, 17: 5265
**BEELER, J. R.**, Diffusion anisotropy in lattices, 17: 5311
**BEETS, C.**, Cross sections for Li$^6$(n,t)He$^4$, 17: 5338
**BEIL, H.**, Determination of thermal neutron absorption, 17: 5319
**BELINFANTE, Frederik J.**, Commuting set of observables in quantum electrodynamics, 17: 5559
**BELL, A. E.**, Radiation effects on reproduction in *T. castaneum* Herbst, 17: 4417
**BELL, J. C.**, Stored energy in graphite of power reactors, 17: 5014
**BELL, R. E.**, Line widths of scintillation counters, 17: 4841
**BELLINGER, Ronald**, Charge chutes for nuclear reactors, 17: 5593
**BELOUSOVA, I. M.**, Concentration of electrode material in plasma of the discharge, 17: 5465
**BENDT, P. J.**, Liquid level He thermometer, 17: 4790
**BENEDICK, W. B.**, Explosively loaded metals yield behavior, 17: 4949
**BENEDICT, Manson**, Extraction by TBP–n-hexane solvents. I., 17: 4634
**BENEZECH, P.**, Ion source of inverse-magnetron type, 17: 5423
**BENOIT-CATTIN, P.**, Precise boring in sensitive volume of G-M counters, 17: 4842
**BENVENISTE, J.**, Gamma rays from interaction of 14-Mev neutrons with Li, 17: 5357
**BERG, J. R.**, Thermodynamic properties of La, Pr, Eu, Yb, and Y, 17: 4929 (IS-327)
**BERGDOLT, G.**, Proton polarization in scattering by O-16 and C-12, 17: 5349
**BERGER, Harold**, Neutron radiography, 17: 4687 (ANL-FGF-378)
**BERKOWITZ, J.**, Magnesium halides study, 17: 4530
**BERLMAN, I. B.**, Quenching of scintillation solution by O$_2$, 17: 4566
**BERNDT, A. F.**, Lattice constants of alpha U–Pu alloys, 17: 4923 (ANL-6460)
**BERNSTEIN, Bruce S.**, Radiation crosslinking of polymers, 17: 4584 (TID-7643(p.245-58))
**BERNSTEIN, Richard B.**, Cross sections for atomic beam scattering, 17: 5090
**BERRY, R. J.**, Radiation effect on mammalian tumor cells, 17: 4411
**BERTANZA, L.**, Properties of the $\Xi^-$ hyperon, 17: 5261
**BERTANZA, L.**, Resonances in $\Xi\pi$ and $K\bar{K}$ systems, 17: 5254
**BERTHOLD, F.**, Measurement of weak $\beta$ emitters in gas phase, 17: 4817
**BERTONI, Henry L.**, Electron density profile, 17: 5439 (PIBMRI-987-62)
**BES, D.**, Spurious state in $\beta$ vibration of nuclei, 17: 5381
**BETCHOV, R.**, Modifying electrical properties of plasma sheath, 17: 5436 (DCAS-TDR-62-79)
**BEU, K. E.**, Determination of lattice parameters, 17: 4490 (GAT-T-1052)
**BEU, Karl E.**, Lattice parameter of W, 17: 4928 (GAT-T-998)
**BEU, Karl E.**, Lattice parameter of Si, 17: 4489 (GAT-T-1051)
**BEU, Karl E.**, Precision of electron diffraction patterns, 17: 4458 (GAT-T-1050)
**BEVIS, Enid**, Radiation grafting of acrylonitrile, 17: 4619
**BEYERMANN, W.**, Prog. rpt. on thermionic converter, 1–3/62, 17: 5637 (AD-275908)
**BHAKAR, B. S.**, "Potential" for low energy $\alpha$-N interaction, 17: 5216
**BHASIN, V. S.**, "Potential" for low energy $\alpha$-N interaction, 17: 5216
**BIALYNICKA-BIRULA, Z.**, Coupling constant in model with unstable particle, 17: 5210
**BIALYNICKI-BIRULA, I.**, Equivalence theorems in quantum field theory, 17: 5534
**BIAĹYNICKI-BIRULA, I.**, Gauge covariant formulation of quantum electrodynamics, 17: 5533
**BIALYNICKI-BIRULA, I.**, Renormalizable theory of vector mesons, 17: 5211
**BIANCHI, G.**, Analysis of "S" neutron-induced resonances, 17: 5295 (CEA-2156)
**BIEN, G. S.**, Radiocarbon dating of deep water, 17: 4713
**BIER, K.**, Chemical method of isotope separation, 17: 4872 (AEC-tr-5527)
**BIER, K.**, Enrichment of C-13, 17: 4871 (AEC-tr-5526)
**BIRD, R. P.**, Double-focusing $\beta$ spectrometer and performance, 17: 4844
**BISHOP, A. E.**, Switch for high-energy capacitators, 17: 4782
**BISHOP, R. L.**, Separation energies for isotopes of Sn and Sb, 17: 5333
**BISWAS, S.**, Hydrogen, He, and heavy nuclei in November 12, 1960 solar cosmic-ray event, 17: 5193
**BLACK, Hugh L.**, Properties of Be sheet metal, 17: 4914
**BLACKBURN, W. S.**, Collapse of tubes of U and SiC, 17: 4958
**BLACKBURN, W. S.**, Irradiation swelling of U under restraint, 17: 5004
**BLAIR, A. G.**, Reaction (He$^3$,t), 17: 5391
**BLAKELEY, J. P.**, Degassing behavior of commercial graphites, 17: 4986
**BLANC, D.**, Precise boring in sensitive volume of G-M counters, 17: 4842
**BLAND, C. J.**, Cosmic ray threshold rigidities, 17: 5191
**BLANKENSHIP, J. L.**, Lithium-drifted diodes in spectrometry, 17: 4857
**BLASER, Robert U.**, Nuclear steam generator, 17: 5632
**BLOK, J.**, Decay of Gd-153, 17: 5392

**BLOK, L.**, Decay of Gd-153, 17: 5392
**BLOUIN, Florine A.**, Radiation-induced graft polymers of cellulose, 17: 4588 (TID-7643(p.319-34))
**BLUE, E.**, Diffusion of electrons in scattering medium, 17: 5241
**BLUM, Lesser**, Evolution of density matrix of large systems, 17: 5114
**BLUM, R.**, Final rpt. on interaction of EM waves with plasma, 4/62, 17: 5431 (AFCRL-62-185)
**BOCKRIS, J. O'M.**, Self-diffusion in molten alkali halides, 17: 4513
**BODINE, S. E.**, Reprocessing irradiated UO$_2$ fuel, 17: 4628 (NAA-SR-7136)
**BOFFI, V. C.**, Neutron decay in a subcritical assembly, 17: 5305
**BOHACHEVSKY, Ihor O.**, Shocks in magnetohydrodynamics, 17: 5489
**BOLLINGER, L. M.**, Neutron detection with glass scintillators, 17: 4835
**BOLLINI, C. G.**, Regge trajectories for square-well potential, 17: 5554
**BOLSTERLI, M.**, Perturbation theory of many-boson systems, 17: 5561
**BOND, V. P.**, Dose-rate dependence of early radiation effects, 17: 4421
**BONILLA, Charles F.**, Vapor pressure of alkali metals, 17: 4947
**BOOMAN, Glenn L.**, Uranium, 17: 4485
**BORGI, A. W.**, Resonance widths for proton capture—graphical method, 17: 5346
**BORISOGLEBSKII, L. A.**, Forbidden transitions in hydrogenlike atoms, 17: 5124
**BORISOVA, I. I.**, Resistance of oxide-metallic films on glass to radiation, 17: 5020
**BORKOWSKI, C. J.**, Guard-ring Si surface-barrier detectors, 17: 4855
**BORKOWSKI, C. J.**, Lithium-drifted diodes in spectrometry, 17: 4857
**BOROVAYA, N. S.**, Determination of Zr, 17: 4474
**BORREGO-LARRALDE, Jose M.**, Semiconductor thermoelements, 17: 5638 (AFCRL-62-148)
**BORYTA, Daniel A.**, Lithium metal–gas reactions, 17: 4522
**BOSCO, B.**, Dispersive formulation of the Levinson theorem, 17: 5228
**BOSCO, B.**, Rescattering correction to deuteron electrodisintegration, 17: 5232
**BOSTICK, W. H.**, Interaction between plasma and dipole, 17: 5477
**BOSTICK, Winston H.**, Properties of plasma eddies, 17: 5482
**BOTTER, Rene**, Analysis of D in H-containing compounds, 17: 4488
**BOTVINKIN, O. K.**, Effect of $\gamma$ radiation on conducting films, 17: 5019
**BOURRET, R. C.**, Stochastically perturbed fields, 17: 5541
**BOUTEN, M.**, Alpha-particle model of Ne-20 and Mg-24, 17: 5374
**BOWEN, P. H.**, Efficiencies for detecting neutrons in organic scintillators, 17: 4836
**BOWMAN, William C.**, Total-absorption scintillation counter, 17: 4854
**BOYARSKI, A. M.**, Decay of $K^+$, 17: 5202 (TID-14840)
**BOYCE, E. J.**, Tritium in fission of U-235, 17: 5337
**BOYLE, W. R.**, Preparation of wood–plastic combinations using radiation, 17: 4589 (TID-7643(p.335-44))
**BOZORTH, R. M.**, Magnetostriction of Gd, 17: 4961
**BOZORTH, R. M.**, Thermal expansion of Gd, 17: 4962
**BRADLEY, N.**, Pressure tube reactors, 17: 5612
**BRADLEY, Norman**, Improvements in reactors, 17: 5595
**BRADLEY, Norman**, Improvements in reactors, 17: 5596
**BRAID, T. H.**, Alpha scattering by Zn-64 and Zn-68, 17: 5358
**BRANCA, Guido**, Aqueous waste disposal in Italian nuclear plants, 17: 5649
**BRANDON, Roy W.**, Resonance in triplet molecules, 17: 4532
**BRANDRETH, D. A.**, Solubilities of LiBH$_4$ and LiH in diethyl ether, 17: 4517
**BRANDSTETR, J.**, Gravimetric methods for Ru based on hydrolysis, 17: 4463
**BRANDT, John C.**, Model of the interplanetary medium, 17: 5165
**BRAR, S. S.**, Airborne radioactivity from weapons tests, 17: 4746
**BRATSEV, V. F.**, Integral representation for Coulomb Green function, 17: 4884
**BREITENLOHNER, P.**, Higher symmetries of strong interactions, 17: 5224
**BREKHOVSKIKH, S. M.**, Resistance of oxide-metallic films on glass to radiation, 17: 5020
**BRESCIANI, Francesco**, Sodium pump in human erythrocytes, 17: 4412
**BRETT, Norman Harry**, Production of sintered UO$_2$, 17: 4922
**BRIDGE, H.**, Stored energy in graphite of power reactors, 17: 5014
**BRISSON, V.**, Properties of the $\Xi^-$ hyperon, 17: 5261
**BRISSON, V.**, Resonances in $\Xi\pi$ and $K\bar{K}$ systems, 17: 5254
**BRODIE, I.**, Thermionic hollow cathodes, 17: 5083
**BRODY, J. K.**, Band spectrum of CuCl molecule. IV., 17: 5070
**BROEK, H. W.**, Alpha scattering by Zn-64 and Zn-68, 17: 5358
**BROSSA, F.**, Nickel as diffusion barrier between U and Al, 17: 4926 (EUR-17.f)
**BROWN, Alexander Baillie**, Production of Be of increased ductility, 17: 4988
**BROWN, Eric**, Brazed seal between two members, 17: 4921
**BROWN, Laurie M.**, Coulomb scattering of spinless particle, 17: 5558
**BROWN, R. R.**, Cosmic noise absorption, 17: 5092
**BROWNE, C. C.**, Water vapor corrosion of beryllia, 17: 4897
**BRUGGER, R. M.**, Phasing two choppers from motor-generator source, 17: 4838
**BRUN, E.**, Nuclear magnetic dipole moment of Ca-41, 17: 5390
**BRUNNER, Witlof**, Theory of $\gamma$-$\gamma$ angular correlation. I., 17: 5328
**BRUNNER, Witlof**, Theory of $\gamma$-$\gamma$ angular correlation. II., 17: 5329
**BRUSH, S. G.**, Interaction of ions and equilibrium concentrations, 17: 5456
**BRUSSAARD, P. J.**, Gaunt factors for Maxwellian electron gas, 17: 5512
**BUCHANAN, J. D.**, Activation analysis with a TRIGA reactor, 17: 4483
**BUCHSBAUM, S. J.**, Gas parity in plasma physics, 17: 5515
**BUCHSBAUM, S. J.**, Interaction between cold plasmas and guided EM waves. II., 17: 5500
**BUCKWALTER, Gary L.**, Liquid scintillation system for interactions of high-energy muons with heavy nuclei, 17: 4809 (NP-12248)
**BUFALINI, M.**, Physical chemistry of isotopic substances, 17: 4511
**BUGLIO, Benjamin**, Activation analysis of Mn and Zn in sea water, 17: 4469
**BUNDY, Willard S.**, Purification of Sr(NO$_3$)$_2$, 17: 4558
**BURGER, L. L.**, Neutral organophosphorus compounds as extractants, 17: 4559 (HW-SA-2796)
**BURKARD, O.**, Photoionization in the F region, 17: 5102
**BURKE, E. C.**, Surface damage in Be, 17: 4937
**BURKE, P. G.**, Scattering of electrons and positrons, 17: 5278
**BURNARD, L. G.**, Production of irradiation plants, 17: 4765
**BURNET, George**, Attack of ferritic steels by Pb–Bi, 17: 4906
**BURNS, John H.**, Crystal structure of Li fluoroantimonate(V), 17: 4502
**BURNS, R. E.**, Solvent extraction studies at Hanford, 17: 4625 (HW-SA-2767)
**BURR, Arthur A.**, Liquid Zr–rare earth alloys, 17: 4943
**BURR, J. G.**, Yield of H from biphenyl, 17: 4605
**BURSHTEIN, A. I.**, Hydrogen atoms formed in silica gel by irradiation, 17: 4615
**BURTON, Milton**, Luminescence decay times, 17: 4565
**BURTON, Milton**, Quenchers in organic scintillator solutions, 17: 4563
**BURTON, Milton**, Quenchers in organic scintillator solutions, 17: 4564
**BUSHONG, R. M.**, New graphites engineering materials, 17: 4968
**BUSLER, William R.**, Radiation-induced polymerization of cyclopentadiene, 17: 4576 (TID-7643(p.118-26))
**BUSSIERE, P.**, Neutron activation analysis of Na, 17: 4482
**BUTLER, S. R.**, Irradiation "factor-dependency" of vinyl monomers, 17: 4571 (TID-7643(p.1-16))
**BYERLY, P. Edward**, Magnetic effects of nuclear explosion, 17: 5105
**BYFIELD, H.**, Interaction between plasma and dipole, 17: 5477

C

**CAIANELLO, E. R.**, Self-coupled meson field, 17: 5230
**CALDARELLA, G. J.**, Irradiation "factor-dependency" of vinyl monomers, 17: 4571 (TID-7643(p.1-16))
**CALVERT, J. M.**, Lifetimes of first excited states of B-10, O-17, and F-17. I., 17: 5353
**CALVI, G.**, Reactions $O^{16}$(d,p) and (d,$\alpha$) at 0.8 to 2.0 Mev, 17: 5367
**CAMBEY, L. A.**, Separation energies for isotopes of Sn and Sb, 17: 5333
**CAMERON, A. G. W.**, Formation of the sun and planets, 17: 5167
**CAMPBELL, C. G.**, Physics problems of water reactors, 17: 5585
**CANUTO, V.**, Partition function of a Bose system, 17: 5119
**CAPPS, Richard H.**, Coupling constants and unsubtracted dispersion relations, 17: 5560
**CARLANDER, R.**, Performance of Al–U alloy fuel plates, 17: 5023
**CARO, R.**, Neutron slowing down in thermal column, 17: 5307
**CARPENTER, Donald Gilbert**, Plasma theory applied to ball lightning, 17: 5518
**CARPENTER, F. D.**, Final rpt. on carbides for thermionic space reactors, 5/15–8/31/62, 17: 5578 (GA-3523)

**CARPENTER, F. G.**, Heat transfer in outgassed powders, 17: 4668
**CARROLL, Jim B.**, Total-absorption scintillation counter, 17: 4854
**CARRUTHERS, J. A.**, Conductivity of electrons in gases, 17: 5072
**CARTER, C. P.**, Preparation of lanthanide halides, 17: 4542
**CARTER, Edward Herbert, Jr.**, Separation of H isotopes by gas chromatography, 17: 4875
**CASALI, F.**, SOPHY—reactor design codes, 17: 4877 (CNEN-141)
**CASEAU, P.**, Plane flows in magnetohydrodynamics, 17: 5524
**CASEY, D. F.**, Liquid metal-heated supercritical steam generator, 17: 5627
**CASPER, Karl J.**, Angular correlation measurements with multichannel analyzers, 17: 4843
**CASSANDRO, M.**, Pion production at threshold, 17: 5222
**CAVENDISH, J. S.**, Drying and calcining of raffinate, 17: 4630
**CEOLIN, C.**, Equation for high-energy cross sections, 17: 5225
**CERMAK, J.**, X-ray monochromator theory, 17: 4778
**CERMAK, J.**, X-ray monochromating unit parameters, 17: 4779
**CERMAN, J.**, Autoinfection after total-body lethal irradiation, 17: 4433
**CERVENJAK, Z.**, Dating of pitchblendes and uraninites, 17: 4709
**CESARANO, Catello**, Post-irradiation experience on irradiated U samples, 17: 4993
**CESS, R. D.**, Forced-convection film boiling, 17: 4677
**CHAIKINA, N. I.**, Concentrating Ag, In and Tl by coprecipitation with Cu diethyldithiocarbaminate, 17: 4475
**CHAMBERLIN, John M.**, Final rpt. on thermodynamic properties of fused salts, 1962, 17: 4496 (TID-17367)
**CHANDRASEKHAR, B. S.**, High-field superconducting solenoid, 17: 4781
**CHANG, B.**, Prog. rpt. on thermionic converter, 1–3/62, 17: 5637 (AD-275908)
**CHANG, David B.**, Bremsstrahlung from plasma, 17: 5502
**CHANG, David B.**, Plasma correction to single-particle cyclotron radiation, 17: 5503
**CHANG, Hua**, Cathodic action of the U chelate compounds. II., 17: 4538
**CHANG, Teh-Liang**, Cathodic action of the U chelate compounds. II., 17: 4538
**CHANG, Tien S.**, MHD stability of vortex flow, 17: 4661 (ORNL-TM-402)
**CHAPIRO, Adolphe**, Radiation-initiated polymerization in solid state, 17: 4578 (TID-7643(p.136-49))
**CHAPIRO, Adolphe**, Radiation grafting, 17: 4582 (TID-7643(p.219-32))
**CHAPMAN, R. N.**, Gamma polymerization of ethylene, 17: 4574 (TID-7643(p.70-106))
**CHEN, C. L.**, Collision cross section of slow electrons and ions with Cs, 17: 5136
**CHEN, F. F.**, Electrostatic stability of collisionless plane discharge, 17: 5464
**CHEN, Ying-Mao**, Solvent extraction of Th with thiocyanate, 17: 4631
**CHENEBAULT, P.**, Sintering of $UO_2$, 17: 4621 (EURAEC-346)
**CHENG, Heng**, Complex plane of angular momentum, 17: 5548
**CHEW, Geoffrey F.**, Nucleon and the (3,3) resonance, 17: 5262
**CHEW, Geoffrey F.**, S-matrix theory of strong interactions, 17: 5570
**CHHABRA, Amrik S.**, $Sr^{90}$–$Y^{90}$ β and bremsstrahlung depth-dose measurements in lucite, 17: 4851
**CHICK, Helen J.**, Bibliography on corrosion by liquid metals, 17: 4904 (LAMS-2779)
**CHICK, Helen J.**, Increase of intensity in time-of-flight measurements, 17: 4810 (AEC-tr-5540)
**CHIDLEY, B. E.**, Glasses for long-term storage on fission products, 17: 5650
**CHILDERS, H. M.**, Coating large refractory metal parts, 17: 4964
**CHILOSI, G.**, Levels in Co-57 from decay of Ni-57, 17: 5378
**CHILTON, F.**, Empirical regularity of weak interactions, 17: 5234
**CHIOZZOTTO, M.**, Control of Ra preparations, 17: 4649
**CHOI, S. S.**, Solubility of Hg in water, 17: 4451
**CHOU, Fu-Chun**, Solvent extraction of Th with thiocyanate, 17: 4631
**CHRISTIE, George Elliot**, Improvements in oxides of U, 17: 4920
**CHUMBLEY, Laurence Clive**, Self-sealing couplings for fluid flow circuits, 17: 4685
**CHUTNÝ, B.**, Gamma oxidation of $Fe^{3+}$ and acetone, 17: 4600
**CIORASCU, F.**, Triggering and adjustments of betatron, 17: 5414
**CIRELLI, R.**, Spin-orbit distortion in deuteron stripping reactions, 17: 5375
**CLAESSON, Arne**, Velocity-dependent neutron transport theory, 17: 5315
**CLARK, G. L.**, Plasmoid dipole rotation in theta pinch, 17: 5495
**CLARKE, H. C.**, Positron annihilation in solid cyclohexane, 17: 4567
**CLAYTON, Roderick K.**, Effects of α radiation on *R. spheroides*, 17: 4416
**CLEGG, A. B.**, Energy levels of B-11 in unified model, 17: 5362
**CLEMENT, C. F.**, Electric polarizability of the deuteron, 17: 5242
**CLEMENT, C. F.**, Nuclear electric field and elastic scattering of deuterons, 17: 5384
**CLIFFORD, J. C.**, Attack of ferritic steels by Pb–Bi, 17: 4906
**CLIKEMAN, Franklyn Miles**, Photoproton reaction in Be-9, 17: 5410
**CLINESMITH, C. R.**, Photoproduction of $\pi^0$ from H, 17: 5253
**CLOSS, Gerhard L.**, Resonance in triplet molecules, 17: 4532
**COCCONI, G.**, Elastic p-p cross sections, 17: 5258
**COCCONI, V. T.**, Elastic p-p cross sections, 17: 5258
**COCHINAL, Roland**, Display device for cyclically checking values, 17: 4657
**COCHRAN, J. S.**, Irradiation of Pu–$UO_2$ fuel, 17: 4898
**COCKBAINE, David Robinson**, Radiation-measuring equipment, 17: 4866
**COCKING, S. J.**, Dynamics of liquid Na by neutron scattering, 17: 4976
**COHEN, S. G.**, Hyperfine interactions of Dy-160 in garnet, 17: 5031 (AFOSR-2535)
**COLE, Julian D.**, Similarity solution for cylindrical MHD blast waves, 17: 5130
**COLEMAN, L. F.**, Air oxidation of U, 17: 4491 (HW-SA-2641)
**COLLINS, C. G.**, Effect of neutron irradiation on Inconel X, 17: 4992
**COLLINS, D. A.**, Recovery of Pa-231 from U waste, 17: 4632
**COLOMBO, P.**, Gamma polymerization of ethylene, 17: 4574 (TID-7643 (p.70-106))
**COLOMBO, R.**, Steam sintering of $UO_2$, 17: 4913
**COLOMBO, S.**, Hypotheses and equations of magnetohydrodynamics, 17: 5522
**COLTMAN, R. R., Jr.**, Reactor damage in pure metals, 17: 5001
**COLWELL, G. T.**, Aerodynamic-thermodynamic study of centrifugal compressors, 17: 4639 (ORNL-3294)
**COMISAR, G. G.**, Structure of strong plasma shock waves in transverse magnetic field, 17: 5434 (DCAS-TDR-62-12)
**COMPOLATTARO, A.**, Self-coupled meson field, 17: 5230
**COMPTON, Arthur**, Feeding irradiated coliform bacilli to mice, 17: 4408
**CONFORTO, G.**, Neutrinoless coherent nuclear capture of $\mu^-$ mesons, 17: 5377
**CONNOLLY, P. L.**, Properties of the $\Xi^-$ hyperon, 17: 5261
**CONNOLLY, P. L.**, Resonances in $\Xi\pi$ and $K\bar{K}$ systems, 17: 5254
**CONSTABLE, James M.**, Radiation meter, 17: 4867
**CONTI, A.**, Separation of inorganic ions by electrophoresis, 17: 4467
**CONVERSI, M.**, Fast-triggering system for spark chambers, 17: 4856
**CONVERSI, M.**, Neutrinoless coherent nuclear capture of $\mu^-$ mesons, 17: 5377
**CONWAY, D. C.**, Distortion of proportional counter spectra, 17: 4853
**COOK, C. J.**, Cross sections for electrons in $N_2$, 17: 5142
**COOK, William R., Jr.**, Radiation damage and ferroelectric effect in Rochelle salt, 17: 5003
**CORGE, C. R.**, Analysis of "S" neutron-induced resonances, 17: 5295 (CEA-2156)
**CORNILLE, H.**, Scattering amplitude of two interactive particles, 17: 5227
**COSTA, S.**, Measurement of $(\gamma,tn)$ reactions induced by synchrotron, 17: 5347
**COTIGNOLA, J. M.**, Distribution of γ rays from oriented nuclei, 17: 5069
**COTTON, F. Albert**, Primary solid hydrides, 17: 4551
**COTTRELL, A. H.**, Stored energy in graphite of power reactors, 17: 5014
**COVINGTON, A. E.**, Flare surge on western limb of sun, 7/20/61, 17: 5181
**COWLEY, R. A.**, Transverse optic mode in Sr titanate, 17: 5141
**COX, D. E.**, Magnetic properties of $FeTiO_3$–$\alpha Fe_2O_3$, 17: 4959
**COX, G. C.**, Efficiencies for detecting neutrons in organic scintillators, 17: 4836
**CRACCO, Francis**, Decay of free radicals in irradiated polyethylene, 17: 4581 (TID-7643(p.200-18))
**CRAIG, P. P.**, Cryogenics, 17: 5065
**CRAIN, C. M.**, Radio wave absorption due to electron-ion collisions, 17: 5044 (RM-3391-PR)
**CRANBERG, Lawrence**, Increase of intensity in time-of-flight measurements, 17: 4810 (AEC-tr-5540)
**CRANGLE, J.**, Ferromagnetism in metals and alloys, 17: 4966
**CRARY, J. H.**, Ionospheric effects of solar flare, 17: 5101
**CRAWFORD, J. H., Jr.**, Nonmetals, 17: 5039 (ORNL-3364(p.85-124))

**CRESPI, H. L.**, Denaturation of deuteriated DNA in $H_2O$ and $D_2O$, 17: 4389
**CREVECOEUR, E. H.**, Measurement of Al-26 and Be-10 in meteorites, 17: 4717
**CREWE, A.**, State nuclear technology, 1/62, 17: 4376 (TID-14912)
**CRIDDLE, W. J.**, Radiation chemistry of carbohydrates. XI., 17: 4599
**CRIMMINS, P. P.**, Spinning of refractory alloys, 17: 4916
**CROTHERS, C. C.**, Performance on Al–U alloy fuel plates, 17: 5023
**CROUCH, W. H., Jr.**, Formation of the solar system. II., 17: 5172
**CROWELL, A. D.**, Physical adsorption of gases, 17: 5159
**CROWLEY-MILLING, M. C.**, 40-Mev electron accelerator for Germany, 17: 5415
**CULLOM, Richard R.**, Magnetic triode for direct energy conversion, 17: 5640 (NASA-TN-D-1532)
**CUMMING, J. B.**, CSLO, Brookhaven decay curve analysis program, 17: 5411
**CUMMINGS, F. W.**, Transition probabilities for system interacting with EM field, 17: 5052
**CURLEE, Neil James, Jr.**, Magnetohydrodynamic channel flow, 17: 4683
**CUSACK, N. E.**, Electron transport in liquid Ga, 17: 4975

# D

**DAANE, A. H.**, Rare-earth alloy systems. I., 17: 4981
**DAANE, A. H.**, Thermodynamic properties of La, Pr, Eu, Yb, and Y, 17: 4929 (IS-327)
**DABBS, J. W. T.**, Nuclear orientation, 17: 5056
**DACHS, H.**, Flat and curved monochromator crystals in neutron spectrometers for investigating single crystals, 17: 4775 (NP-tr-923)
**DAINTON, F. S.**, Radiolysis of aqueous systems, 17: 4614
**DAMBURG, R.**, Multichannel effective range theory and electron–H scattering, 17: 5150
**DAMM, C. C.**, Plasma production by neutral-atom injection, 17: 5473
**DAMON, Paul E.**, Color centers in fluorite, 17: 5094
**DANIELS, J. M.**, Distribution of γ rays from oriented nuclei, 17: 5069
**DANIELS, J. M.**, Distribution of γ rays from Mn-54, 17: 4509
**DANIELS, J. M.**, Nuclear orientation of Mn-54, 17: 4510
**DANKO, J. C.**, Steam sintering of $UO_2$, 17: 4913
**DARWENT, B. deB.**, Reaction of methyl-$d_3$ radicals with isobutane, 17: 4562
**DAS, K. B.**, Electric resistivity of Mg-Nd alloys, 17: 4951
da Silva, J. Gomes
    *see Gomes da Silva, J.*
**DAUNT, J. G.**, Phase separation in solid $He^3$–$He^4$ mixtures, 17: 5145
**DAVIDSON, J. M.**, Radiation effects on carbons and graphites, 17: 4989 (HW-SA-2368)
**DAVIDSON, J. P.**, Model for deformed even nuclei, 17: 5331
**DAVIES, David Reginald**, Apparatus for loading and unloading heterogeneous nuclear reactors, 17: 5604
**DAVIS, Leverett, Jr.**, Boundary between magnetic field and plasma, 17: 5454
**DAVIS, Sumner P.**, Spectrum of Hg hydride, 17: 5109
**DAVIS, W. C.**, High-speed rotating-mirror framing camera, 17: 4776
**DAWSON, J. K.**, Problems in water reactors, 17: 4907
**DAWSON, John**, High-frequency conductivity of fully ionized plasma, 17: 5497
**DEAN, Reginald S.**, Compounds of Zr and preparation, 17: 4555
**DE BAR, R. B.**, Rescattering correction to deuteron electrodisintegration, 17: 5232
**DE BEAUREGARD, Olivier Costa**, Graviton of spins 2, 1, and 0, 17: 5538
**DE BROGLIE, Louis**, Thermodynamics of isolated particle, 17: 5212
**DE BUCS, E. v. Szabo**, Production of short-lived radionuclides, 17: 4759
**DE CAMARGO, W. G. R.**, Dioxane addition compounds, 17: 4452
**DEDRICK, K. G.**, Kinematics of high-energy particles, 17: 5277
**DE FELICE, J.**, Radioactivities in meteorites, 17: 4708
**DEGERING, Ed. F.**, Irradiation "factor-dependency" of vinyl monomers, 17: 4571 (TID-7643(p.1-16))
**DEITZ, V. R.**, Heat transfer in outgassed powders, 17: 4668
**DELBOURGO, R.**, Final state scattering, 17: 5356
**DELEON, G.**, Dating of pitchblendes and uraninites, 17: 4709
**DELMAS, R.**, Sintering of $UO_2$, 17: 4621 (EURAEC-346)
**DE MEVERGNIES, M. Neve**, Cold neutron sources, Programs in Europe, 17: 5296 (EANDC-22L)
**DEMINT, Robert J.**, Effects of γ radiation on cotton. IV., 17: 5021
**DENISOV, N. G.**, EM-wave parameters after passing through plasma in magnetic field, 17: 5445
**DE PRETIS, M.**, Photoproduction of muon pairs in C, 17: 5260
**DESCHAMPS, N.**, Radioactivation analysis of Al, Fe, and Zr, 17: 4480
**DESLOGE, Edward A.**, Exchange of energy between gases, 17: 5128
**DESSLER, A. J.**, Interface between solar wind and geomagnetic field, 17: 5173
**DE SWART, J. J.**, Λ-Nucleon scattering and pion-hyperon coupling constants, 17: 5247
**DE TEJADA GONZALEZ, Luis M. Saenz**, Micrographic study of metal deposits on incandescent filaments, 17: 4890
**DE VILLIERS, J. W. L.**, Diffusion cooling in graphite, 17: 5293 (BNL-5987)
**DEWAN, John T.**, Radioactive borehole logging apparatus, 17: 4865
**DEYRIS, M.**, Radioactivation analysis of Al, Fe, and Zr, 17: 4480
**DICKINSON, Hillman**, Rayleigh-Taylor instability in plasma, 17: 5516
**DICKINSON, R. W.**, Liquid metal-heated supercritical steam generator, 17: 5627
**DI LELLA, L.**, Fast-triggering system for spark chambers, 17: 4856
**DI LELLA, L.**, Neutrinoless coherent nuclear capture of $\mu^-$ mesons, 17: 5377
**DI NUNZIO, G.**, Control of Ra preparations, 17: 4649
**DIVITA, Edward L.**, Space radiation doses in spacecraft, 17: 5646
**DODT, G.**, Measurement of thermal neutron flux, 17: 4825
**DOLE, Malcolm**, Decay of free radicals in irradiated polyethylene, 17: 4581 (TID-7643(p.200-18))
**DOMANUS, Józef**, Application of large radiation sources, 17: 4758
**DONACHIE, Matthew J., Jr.**, Behavior of stainless steel in He, 17: 4980
**DONALDSON, E. E.**, Electrical breakdown in vacuum, 17: 4640 (TID-15465)
**DONATO, Matteo**, Radiation effects on p- and n-type catalysts, 17: 4569 (NP-12250)
**DONNEAUX, E.**, Cross sections for $Li^6(n,t)He^4$, 17: 5338
**DOPCHIE, H.**, Operational parameters of BR2 reactor, 17: 5574 (BLG-119)
**DOUGLASS, D. H., Jr.**, Superconducting transition temperature of superimposed films, 17: 5139
**DOUGLASS, D. H., Jr.**, Superimposed films of superconducting metals, 17: 5140
**DOW, James**, Sterilization of adhesive dressings, 17: 4763
**DOYLE, Margaret V.**, Superconductors as permanent magnets, 17: 5084
**DRABKIN, G. M.**, Energy spectra of polarized neutrons, 17: 5285
**DRAGOS, Lazare**, Theory of thin flanges in magnetohydrodynamics, 17: 4664
**DRAGOS, Lazare**, Thin flanges in magnetohydrodynamics, 17: 5077
**DRAGT, A. J.**, Analyticity and unitarity general transition amplitudes, 17: 5547
**DREICER, H.**, Drift instabilities by collisional relaxation of high-energy particles, 17: 5499
**DREICER, H.**, Drift instabilities and particle relaxation, 17: 5514
**DRESDEN, M.**, Field theories with one-particle states. I., 17: 5571
**DRESIA, H.**, Measurement of thermal neutron flux, 17: 4825
**DRESSELHAUS, G. F.**, Ferro- and antiferromagnetism in cubic cluster of spins, 17: 5027 (AD-273950)
**DRISKO, R. M.**, Inelastic scattering of α particles. I., 17: 5382
**DRUMMOND, William E.**, Anomalous diffusion from microinstabilities in plasma, 17: 5496
**DUCKWORTH, H. E.**, Separation energies for isotopes of Sn and Sb, 17: 5333
**DUFFY, Wayne E.**, Polyphenyl reactor coolant, 17: 5602
**DUIMIO, F.**, Equation for high-energy cross sections, 17: 5225
**DUMIN, David J.**, Transmission system for driving cryogenic circuits, 17: 4788
**DUNDAS, P. H.**, Measuring plasma jet temperatures, 17: 5443 (WADD-TR-60-676(Pt.II))
**DUNGEY, J. W.**, Interplanetary magnetic field and auroral zones, 17: 5028 (AFCRL-62-423)
**DUNN, M. H.**, Energy from Carnot engine with thermally ionized gas, 17: 5088
**DUPLAN, J. F.**, Cortisone and radiation effects on leukemogenesis, 17: 4396
**DURBIN, Leo**, Diffusion of Kr-85 in dense gases, 17: 4524

**DURNEY, A. C.,** Particle flux produced by high-altitude explosion, 7/9/62, 17: 5115

**DUTEIL, P.,** DISC counter with liquid radiator, 17: 4827

**DYRING, Eric,** Direction of the cosmic ray anisotropy, 17: 5196

**DYSON, J.,** Electron density Sceptre IV, 17: 5463

## E

**EBERT, H.,** Measurement of low activities, 17: 4819

**ECKHAUSE, Morton,** Negative muon lifetimes in light isotopes, 17: 5324 (NYO-9286)

**EDGE, R. D.,** Nuclear excitation by 180° electron scattering, 17: 5388

**EDLING, N. P. G.,** Renal angiography with ThO$_2$, 17: 4382

**EDMONDS, G. D.,** Switch for high-energy capacitators, 17: 4782

**EDWARDS, D. O.,** Phase separation in solid He$^3$–He$^4$ mixtures, 17: 5145

**EDWARDS, E.,** Radiation-induced dilatations in vitreous silica, 17: 5016

**EDWARDS, J.,** Problems of submarine PWR design. I., 17: 5613

**EDWARDS, J.,** Problems of submarine PWR design. II., 17: 5614

**EFREMOV, G. V.,** Concentrating Ag, In and Tl by coprecipitation with Cu diethyldithiocarbaminate, 17: 4475

**EGARDT, L.,** Decay of $\lambda_{11}$, 17: 5223

**EICHELBERGER, J. F.,** Prog. rpt., 1/62, 17: 4374 (MLM-1129)

**EICHELBERGER, J. F.,** Prog. rpt., 2/62, 17: 4375 (MLM-1133)

**EICHER, H.,** Hyperfine structure splitting of $\gamma$ lines. V., 17: 5406

**EICHHORN, R.,** Unsteady natural convection in vertical plate, 17: 4672

**ELDRIDGE, O.,** Fokker-Planck coefficients for plasma, 17: 5478

**ELIOFF, Tom,** Pion-pion interactions, 17: 5252

**ELKINS, P. G.,** Decametric wave-length absorption from nuclear explosion, 7/9/62, 17: 5116

**ELKINS, S. R.,** Final rpt. on high-temperature ceramic structures, 11/1/61–10/31/62, 17: 4931 (NP-12306)

**ELLARD, J. A.,** Prog. rpt. on organic coolants, 4/1–5/30/62, 17: 5578 (IDO-11002)

**ELLIOTT, Jack H.,** Semiconductor transmission-counter system, 17: 4852

**ELLIS, W. P.,** Smear techniques for surface monitoring for radioactive materials, 17: 4743 (ORNL-TM-435)

**ELLS, C. E.,** Behavior of H in Be, 17: 4941

**EL-NESR, M. S.,** Half life of 152-kev transition in W-182, 17: 5394

**ELVING, Philip J.,** Uranium, 17: 4485

**EL-WAKIL, M. M.,** *Nuclear Power Engineering* (book), 17: 5630

**EMAN, B.,** Anomalous shape in allowed $\beta$ spectra, 17: 5370

**EMMONS, H. W.,** Poiseuille plasma experiment, 17: 5494

**ENDEBROCK, Roy W.,** Properties of fuels for high-temperature reactor concepts, 17: 5575 (BMI-1598)

**ENGELDINGER, P.,** Turbulence and charge loss in flows, 17: 5525

**ENGLAND, J. B. A.,** Scattering of He-3 particles by N-14 and O-16, 17: 5363

**ENGLAND, J. B. A.,** Scattering of He-3 particles by C, F, S, and Br, 17: 5364

**EPSTEIN, Samuel,** Origin of tektites, 17: 5093

**ERDAL, Bruce,** Bibliographies on isotopic exchange reactions, 17: 4494 (SCR-512)

**ERICSON, William B.,** Transverse MHD flow past semi-infinite plate, 17: 5485

**ERPENBECK, Jerome J.,** Stability of step shocks, 17: 5127

**ESKIND, Neil A.,** Alpha-particle backscattering, 17: 5100

**ESTERLING, R. J.,** Distributions in one-dimensional plasma sheaths, 17: 5452

**EVANS, F. E.,** Irradiation "factor-dependency" of vinyl monomers, 17: 4571 (TID-7643(p.1-16))

**EVANS, M. D.,** Gamma-induced defects in single-crystal $\alpha$-Al$_2$O$_3$, 17: 4997

**EVANS, W.,** Behavior of H in Be, 17: 4941

**EVERSON, I.,** DIDO research reactor and use, 17: 5636

**EWING, C. T.,** Specific heat of materials, 17: 4523

**EYRE, B. L.,** Slip bands in irradiated pure Fe, 17: 5011

**EYRING, H.,** Gamma-induced defects in single-crystal $\alpha$-Al$_2$O$_3$, 17: 4997

## F

**FABRE, J.,** MHD generation of electrical energy, 17: 5527

**FAILLA, G.,** Determination of absorbed dose from x rays, 17: 4850

**FAIRBAIRN, H. W.,** Geochronology by Sr isotope variations, 17: 4706

**FALCKENBERG, H. R.,** Gas density gauging, 17: 4777

**FALK, Theodore J.,** Diffusion in one-dimensional pinch, 17: 5474

**FARMER, F. R.,** Simplification of reactor safety, 17: 5584

**FARMER, O. A.,** Programs for para-hydrogen properties, 17: 4493 (LAMS-2762)

**FAUGHNAN, Brian W.,** Radiation-induced changes in Si cells, 17: 4995

**FAURE, G.,** Geochronology by Sr isotope variations, 17: 4706

**FAWCETT, Sherwood L.,** Triode concept of direct conversion, 17: 5068

**FEA, G.,** Meteorological information for reactor startup, 17: 4694

**FEDELE, D.,** Meteorological information for reactor startup, 17: 4694

**FEDERIGHI, F. D.,** Calculating fast few-group constants, 17: 5298 (KAPL-2220)

**FEDERIGHI, T.,** Neutron irradiation effects of Al dislocation damping, 17: 5013

**FEDOROV, N. F.,** Stabilization of dicalcium silicates, 17: 4548

**FEIN, A. E.,** Scattering of neutrons by anharmonic crystal, 17: 5317

**FEIX, M.,** Fokker-Planck coefficients for plasma, 17: 5478

**FELIX, F.,** Production of short-lived radionuclides, 17: 4759

**FELL, J.,** Physics problems of water reactors, 17: 5585

**FELTON, C. D.,** Radiation grafting of chloromethylstyrene to polypropylene, 17: 4590 (TID-7643(p.345-97))

**FEOFILOV, P. P.,** Spectra of Eu by Yb in fluorides, 17: 4547

**FERGUSON, E. E.,** Metastable He atom concentrations, 17: 5149

**FERRARI, H. M.,** Steam sintering of UO$_2$, 17: 4913

**FERRARO, V. C. A.,** Diffusion and drift in F2 region, 17: 5029 (AFCRL-62-623)

**FERRONI, S.,** Measurement of ($\gamma$,tn) reactions induced by synchrotron, 17: 5347

**FERZIGER, Joel H.,** Resonance absorption of neutrons in lumps, 17: 5310

**FICHTEL, C. E.,** Hydrogen, He, and heavy nuclei in November 12, 1960 solar cosmic-ray event, 17: 5193

**FICKLER, Stuart Irwin,** Quantization of Yang-Mills field, 17: 5160

**FIEGEL, Leon J.,** Unit cell and space group of 2Nb$_2$O$_5$–Ta$_2$O$_5$, 17: 4505

**FIELD, F. H.,** Reactions of rare gases with N$_2$ and CO, 17: 4527

**FILATOVA, E. F.,** Absorption of electrolytes on ZrO$_2$, 17: 4500 (AEC-tr-5529)

**FINKELMAN, E. N.,** Optimized protection against environmental hazards in space, 17: 5528

**FINNISTON, Harold Montague,** Improvements in reactor fuel elements, 17: 5589

**FIORE, Cesare,** Sodium pump in human erythrocytes, 17: 4412

**FIREMAN, E. L.,** Density of solar flare plasma, 17: 5187

**FIREMAN, E. L.,** Radioactivities in meteorites, 17: 4708

**FISCHER, F. K.,** Working fluids for power generation, 17: 5628

**FISHMAN, F. J.,** Magnetic annular shock-tube operation, 17: 5466

**FLAMMER, Carson,** Final rpt. on interaction of EM waves with plasma, 4/62, 17: 5431 (AFCRL-62-185)

**FLANIGAN, David Addison,** Polarography of rare earth metal ions, 17: 4486

**FLICKER, H.,** Radiation defect introduction rates in n- and p-type Si, 17: 5015

**FODOR, G.,** Irradiated specimen activity during stopped reactor operations, 17: 4594

**FOELSCHE, H.,** Properties of the $\eta$ meson, 17: 5259

**FOOTE, Frank G.,** Plutonium fuel programs at Argonne, 17: 4887 (ANL-FGF-393)

**FORCE, Charles T.,** Estimation of sounding rocket trajectories, 17: 5066

**FORD, C. E.,** New graphites engineering materials, 17: 4968

**FOREMAN, Harry,** Toxicology: inorganic, 17: 4388

**FORTNEY, Lloyd Roy,** Lifetimes of light hyperfragments, 17: 5292

**FOURNET, L.,** Radioactivation analysis of Al, Fe, and Zr, 17: 4480

**FOWLER, E. C.,** Properties of the $\eta$ meson, 17: 5259

**FOX, C. W.,** Prog. rpt. on brazing ceramics, 11/62, 17: 4912 (ORNL-TM-413)

**FOX, R. J.,** Guard-ring Si surface-barrier detectors, 17: 4855

**FOX, Raymond,** Heat-shielded magnetically channeled plasma heat converter, 17: 5643 (UCRL-6553)

**FRANCIS, Roy N.,** Changes in earth magnetic field from high-altitude explosion, 7/9/62, 17: 5106

**FRANK, L. A.,** Electrons in outer radiation zone, 17: 5183

**FRANKLIN, J. L.,** Reactions of rare gases with N$_2$ and CO, 17: 4527

**FRASER, B. J.,** Geomagnetic micropulsations from nuclear explosion,

17: 5103

**FRASER, J. S.**, Fission studies on U-233, U-235, and Pu-239, 17: 5334

**FREAS, D. G.**, Irradiation damage in UC, 17: 4900

**FRED, Mark**, Slater parameters for Hf III spectrum, 17: 5148

**FREILING, E. C.**, Nuclear debris in sea water, 17: 4750

**FREUND, P. G. O.**, Regge poles and validity of Rosenbluth formula, 17: 5555

**FREYER, K.**, Distribution of $\beta$ substances on surfaces, 17: 4757

**FRIED, David L.**, Magnetic moment of Lee particle, 17: 5249

**FRIEDMAN, A. M.**, Gas entrainment recoil target assembly, 17: 5422

**FUBINI, S.**, Equation for high-energy cross sections, 17: 5225

**FUCHS, V.**, Particles with two mass states, 17: 5213

**FUHS, A. E.**, Modifying electrical properties of plasma sheath, 17: 5436 (DCAS-TDR-62-79)

**FUJITA, Jun-Ichi**, Vector interactions in $\beta$ decay, 17: 5400

**FUJIWARA, K.**, Radiation-induced polymerization of ketene, 17: 4572 (TID-7643(p.28-55))

**FUKAI, Rinnosuke**, Activation analyses in marine organisms, 17: 4468

**FULTON, T.**, Conformal invariance in physics, 17: 5572

**FURUICHI, Susumu**, Lepton energy spectra in $K^{\pm}_{e3}$-decay, 17: 5275

**FUSCHINI, E.**, Internal Compton effect, 17: 5123

**FUTCH, A. H., Jr.**, Plasma production by neutral-atom injection, 17: 5473

**FUTRELL, Jean H.**, Rare-gas sensitized radiolysis of propane, 17: 4601

**FYFE, Walter I.**, Ionization behind shock waves in air. I., 17: 5131

# G

**GABELNICK, S. D.**, Irradiation "factor-dependency" of vinyl monomers, 17: 4571 (TID-7643(p.1-16))

**GABRYSH, A. F.**, Gamma-induced defects in single-crystal $\alpha$-Al$_2$O$_3$, 17: 4997

**GAIN, R.**, Construction of irradiation capsules for graphite, 17: 5006

**GĂINAR, E.**, Neutron capture in bichromates, 17: 4595

**GĂINAR, I.**, Neutron capture in bichromates, 17: 4595

**GAIZAUSKAS, V.**, Flare surge on western limb of sun, 7/20/61, 17: 5181

**GALBRAITH, W.**, Charged $\pi$ meson production in p-p collisions, 17: 5199 (AERE-R-3969)

**GALE, N. H.**, Lifetimes of first excited states of B-10, O-17, and F-17. I., 17: 5353

**GALE, N. H.**, Lifetimes of first excited states of B-10, O-17, and F-17. II., 17: 5354

**GALLI, M.**, Diurnal oscillations of cosmic rays, 17: 5188

**GALLMANN, A.**, Proton polarization in scattering by O-16 and C-12, 17: 5349

**GANDOLFO, F. W.**, Reprocessing irradiated UO$_2$ fuel, 17: 4628 (NAA-SR-7136)

**GARABEDIAN, H. L.**, Analytic approach to two-dimensional reactor theory, 17: 5312

**GARCIA, A.**, Scattering of He-3 particles by C, F, S, and Br, 17: 5364

**GARG, J. B.**, Lifetimes of first excited states of B-10, O-17, and F-17. I., 17: 5353

**GARRETA, D.**, Ion source of inverse-magnetron type, 17: 5423

**GARRIDO, L. M.**, Observables of relativistic particles, 17: 5208

**GASKELL, T.**, Collective treatment of many-body systems. III., 17: 5566

**GAUMER, R. E.**, Research in space materials, 17: 4985

**GAUTSCHI, Walter**, Diffusion functions for small argument, 17: 4883

**GAVIN, A. P.**, Performance on Al–U alloy fuel plates, 17: 5023

**GEBAUER, H.**, Measurement of radioactive substances in water, 17: 4815

**GELBERG, A.**, Measurement of $\beta-\gamma$ circular polarization correlations, 17: 4830

**GELLER, K. N.**, Energy control and calibration of 23-Mev betatron, 17: 5426

**GELLI, D.**, Neutron irradiation effects of Al dislocation damping, 17: 5013

**GENIN, R.**, Determination of thermal neutron absorption, 17: 5319

**GENTNER, W.**, Isotopic displacements in meteorites, 17: 4702

**GERHART, J. M.**, Irradiation of Pu–UO$_2$ fuel, 17: 4898

**GERRITSEN, A. N.**, Electric resistivity of Mg-Nd alloys, 17: 4951

**GERSHMAN, B. N.**, Group velocity of plasma waves, 17: 5444

**GEYMER, D. O.**, Radiation-induced polymerization of $\alpha$-olefins, 17: 4573 (TID-7643(p.56-69))

**GHEZZI, Ernesto**, Post-irradiation experience on irradiated U samples, 17: 4993

**GIAMBIAGI, J. J.**, Regge trajectories for square-well potential, 17: 5554

**GIBB, T. R. P., Jr.**, Metallic hydride formation, 17: 4541

**GIBB, Thomas R. P., Jr.**, Primary solid hydrides, 17: 4551

**GIBBON, Ronald Bryan**, Improvements in reactor fuel elements, 17: 5589

**GIBBONS, P. E.**, Bulk ionization semiconductor detectors, 17: 4837

**GIERTS, G.**, Cross sections for Li$^6$(n,t)He$^4$, 17: 5338

**GIESBRECHT, E.**, Dioxane addition compounds, 17: 4452

**GILBERT, Alan Richard**, Production of metal-strip capacitors, 17: 4798

**GILLAM, E.**, Relationship between UO$_2$(tetragonal) and U$_2$C$_3$(cubic), 17: 4503

**GILLET, Vincent**, System of large number of particles, 17: 5540

**GINTHER, R. J.**, Neutron detection with glass scintillators, 17: 4835

**GIRARDEAU, M.**, Condensation in many-boson systems, 17: 5557

**GLANZ, G.**, Irradiation device attached to reactor, 17: 4991

**GLASCOCK, Homer H., Jr.**, Fusion energy of 60BeO–40CaO, 17: 4950

**GLASHOW, S. L.**, Similarities of weak, strong, and electromagnetic interactions, 17: 5238

**GLASSER, Otto**, Physical Foundations of Radiology, 3rd Ed., 17: 4431

**GODFREY, T. G.**, Thermal conductivity of INOR-8, 17: 4942

**GOEDBLOED, W.**, Decay of Gd-153, 17: 5392

**GOEDDEL, Walter V.**, Summary of coated-particle-fuels development. 10/61-4/62, 17: 4888 (GA-3109)

**GOJKOVIC, S.**, Dating of pitchblendes and uraninites, 17: 4709

**GOLD, Lewis Peter**, Resonance spectra of alkali halides, 17: 4554

**GOLDNER, Ronald B.**, Surface energy parameter of Pb, 17: 4953

**GOLDSTEIN, L.**, Anomalous liquid-solid transformation of He-3, 17: 5133

**GOLDSTEIN, Martin**, Neutron-damaged vitreous silica, 17: 4952

**GOMER, R.**, Desorption of Cs from W, 17: 4525

**GOMES DA SILVA, J.**, Oxidation yield in Fricke dosimetry of P-32 $\beta$ radiation, 17: 4597

**GOMEZ, R.**, Photoproduction of $\pi^0$ from H, 17: 5253

**GONELLA, Luigi**, High-voltage trapezoidal pulse generator, 17: 4769 (IS-432)

Gonzalez, Luis M. Saenz de Tejada

*see de Tejada Gonzalez, Luis M. Saenz*

**GOODMAN, T. R.**, Incompressible heat transfer, 17: 4674

**GOODRICH, G. W.**, Continuous-channel electron multiplier, 17: 4792

**GORMAN, John K.**, Shallow donor thermionic emitter, 17: 5079

**GORODETZKY, S.**, Proton polarization in scattering by O-16 and C-12, 17: 5349

**GORZHEVSKAYA, E. G.**, Photoproduction of $\pi^+$ mesons, 17: 5287

**GOSHORN, John C., Jr.**, Calibration of T(d,n)He$^4$ yield from positive ion accelerator, 17: 5412 (NDL-TM-6)

**GOTO, Junko**, Nucleon-nucleon scattering in momentum space, 17: 5271

**GOTTSCHALD, J.**, Measurement of low activities, 17: 4819

**GOUPIL, Jean**, Display device for cyclically checking values, 17: 4657

**GRABOWSKY, W. R.**, Prog. rpt. on energy conversion, 7–12/61, 17: 5639 (DCAS-TDR-62-32)

**GRAND, R. J.**, Radiation effects on incorporation of C$^{14}$-formate into RNA purines, 17: 4397

**GRASHOW, S. L.**, On the tenfold way, 17: 5233

**GRASSINI, G.**, Separation of inorganic ions by electrophoresis, 17: 4467

**GRAY, A. L.**, Gamma-sensitive ionization chamber, 17: 4846

**GRAYHEK, V. G.**, High Power Density development project, 17: 5607 (GEAP-3860)

**GRECESCU, M.**, Triggering and adjustments of betatron, 17: 5414

**GREENE, John M.**, Equilibrium and stability for systems with small curvature, 17: 5438 (MATT-89)

**GREENFIELD, Irwin Gilbert**, Neutron radiation damage in Cu, 17: 5024

**GREENOUGH, G. B.**, Stored energy in graphite of power reactors, 17: 5014

**GREIFINGER, Carl**, Similarity solution for cylindrical MHD blast waves, 17: 5130

**GRIBOV, V. N.**, Elastic scattering amplitude at high energies, 17: 5217

**GRIBOV, V. N.**, Regge poles and Landau singularities, 17: 5264

**GRIBOVA, P. A.**, Myelopoiesis in x rays and benzole intoxication, 17: 4403

**GRIDNEV, V. N.**, Formation of $\omega$ phase in Hf alloys, 17: 4979

**GRIFFIN, C. W.**, SRE prompt power coefficient, 17: 5588

**GRIFFITHS, D. J.**, Distribution of $\gamma$ rays from Mn-54, 17: 4509

**GRIFFITHS, D. J.**, Nuclear orientation of Mn-54, 17: 4510

**GRIFFITHS, R. J.**, Bulk ionization semiconductor detectors, 17: 4837

**GRISANTI, A.**, Control of Ra preparations, 17: 4649

**GRITSYUK, Y. N.**, Neutron emitted by U-236 in symmetric fission region, 17: 5351
**GROSMANN, Michel**, Radiation effects on absorption spectrum of cuprite, 17: 4994
**GROSS, W.**, Determination of absorbed dose from x rays, 17: 4850
**GROVER, J. R.**, Glasses for long-term storage on fission products, 17: 5650
**GRUN, Jean-Bernard**, Radiation effects on absorption spectrum of cuprite, 17: 4994
**GSCHNEIDNER, K. A., Jr.**, Departures from Vegard's law, 17: 4955
**GUENTHER, Reiner**, Electron emission current nuclear reactor, 17: 5162
**GUILLET, M. L.**, Modulus of elasticity of metallic alloys, 17: 4934 (AEC-tr-5534)
**GULMANELLI, P.**, Spin-orbit distortion in deuteron stripping reactions, 17: 5375
**GUON, J.**, Reprocessing irradiated UO$_2$ fuel, 17: 4628 (NAA-SR-7136)
**GUPTA, Priyansu Sen**, Pulsating universe, 17: 5176
**GUSH, H. P.**, Infrared spectrum of solid H, 17: 5071
**GUSS, D. E.**, Hydrogen, He, and heavy nuclei in November 12, 1960 solar cosmic-ray event, 17: 5193
**GUSTAFSON, P. F.**, Airborne radioactivity from weapons tests, 17: 4746
**GWIN, R.**, Scintillation process in CsI(Tl), 17: 5034 (ORNL-3354)
**GYODA, T.**, Radiation hygiene in U mines, 17: 4747

## H

**HABASHI, Fathi**, Uranium content of marine phosphates, 17: 4695
**HABERER, K.**, Measurement of radioactivity in water, 17: 4816
**HADEISHI, Tetsuo**, Metastable state of Ne atom under electron impact, 17: 5046 (UCRL-10477)
**HADJIOANNOU, F.**, Regge pole model for p-p and $\bar{p}$-p scattering, 17: 5255
**HAGUE, John L.**, Separation of Hf from Zr and determination, 17: 4633
**HAKKILA, E. A.**, X-ray absorption edge of Co, 17: 4462
**HALBACH, Klaus**, Production of hot rotating plasma, 17: 5492
**HALL, L. S.**, Harrison-Thompson generalization of Bohm's sheath condition, 17: 5508
**HALL, Lawrence S.**, Thermodynamic cycling in magnetic pumping, 17: 5442 (UCRL-6355)
**HALL, R.**, Radiation effects on incorporation of C$^{14}$-formate into RNA purines, 17: 4397
**HALLAM, J. W.**, Solid state charged particle Si detectors, 17: 4804 (ARL-62-406)
**HALTRICH, S.**, Triggering and adjustments of betatron, 17: 5414
**HAMABE, Naohiko**, Production of UF$_4$ from U raw material, 17: 4624
**HAMILTON, J. H.**, Internal conversion in I-132 decay, 17: 5371
**HAMMEL, E. F.**, Cryogenics, 18: 5065
**HAMMITT, Frederick G.**, Radioisotopic measurement of cavitation and erosion damage, 17: 4971
**HAMMOND, D. V.**, Final prog. rpt. on compatibility of materials with K, 4/60–12/61, 17: 4905 (NP-12334)
**HAMPTON, James C.**, Radiation effects on intestinal epithelium. I., 17: 4420
**HANRATTY, Thomas J.**, Stability of flow in a vertical pipe, 17: 4669
**HANSEN, K. F.**, Multi-group diffusion methods, 17: 5581 (NYO-10206)
**HANSEN, Robert S.**, Colloid and surface chemistry, 17: 4516
**HARA, Akira**, Radiation-induced polymerization of acrylonitrile, 17: 4612
**HARMAN, T. C.**, Galvano-thermomagnetic energy conversion devices. I., 17: 5080
**HARMAN, T. C.**, Galvano-thermomagnetic energy conversion devices. II., 17: 5081
**HARMISON, L. W.**, Preparation of wood–plastic combinations using radiation, 17: 4589 (TID-7643(p.335-44))
**HARRIS, Isadore**, Models for solar-cycle variation, 17: 5170
**HARRIS, R. W.**, Phase-shift analysis of scattering of protons from O, 17: 5355
**HARRISON, John David Lawrence**, Production of sintered UO$_2$, 17: 4922
**HARTMANN, G.**, Distribution of $\beta$ substances on surfaces, 17: 4757
**HARTZ, T. R.**, Cosmic noise absorption, 17: 5092
**HASAPIS, A. A.**, Vaporization and physical properties of refractories, 17: 4933 (WADD-TR-60-463(Pt.II))
**HASHITANI, H.**, Bibliography on analytical chemistry of reactor fuels and materials, 17: 4461 (JAERI-4023)
**HAVAS, Peter**, Corrections in statistical mechanics of interacting particles, 17: 5564
**HAVILAND, J. K.**, Heat transfer in rarefied gas, 17: 4680
**HAVILAND, R. P.**, Charging of radiation belts, 17: 5067
**HAYASHI, Hirofumi**, Resonances in terms of compound states, 17: 5268
**HAYASHI, K.**, Radiation-induced polymerization of ketene, 17: 4572 (TID-7643(p.28-55))
**HAYASHI, K.**, Radiation-induced polymerization of cyclic monomers, 17: 4579 (TID-7643(p.150-77))
**HAYASHI, Koichiro**, Radiation-induced copolymerization, 17: 4613
**HAYCOCK, Obed C.**, Plasma frequency probe, 17: 5078
**HEAD, R. M.**, Modifying electrical properties of plasma sheath, 17: 5436 (DCAS-TDR-62-79)
**HEALY, James H.**, Unit cell and space group of $2Nb_2O_5-Ta_2O_5$, 17: 4505
**HEARETH, H. C.**, Drying and calcining of raffinate, 17: 4630
**HEBERT, Alvin Joseph**, Molecular-beam electric-resonance spectrometer and spectra of LiF, 17: 4499 (UCRL-10482)
**HECKROTTE, W.**, Plasma production by neutral-atom injection, 17: 5473
**HEDMAN, Sven**, Fuel composition for aqueous homogenous reactors, 17: 5605
**HEGBERG, D. E.**, Band structure of CaF$_2$:Mn, 17: 5033 (HW-70230)
**HEIMLICH, C. W.**, Spinning of refractory alloys, 17: 4916
**HELHOLTZ, J.**, Dancoff correction in gap geometry, 17: 5309
**HELLRIEGEL, Werner**, Bladder tumors after radiation therapy, 17: 4385
**HELLSTRAND, E.**, Resonance integral of Nb, 17: 5320 (AE-81)
**HELM, J. W.**, Radiation effects on carbons and graphites, 17: 4989 (HW-SA-2368)
**HEMPFLING, Gerald L.**, Scanning mechanism for x-ray spectrometer, 17: 4808 (NASA-TN-D-1097)
**HENDERSON, C. M.**, Prog. rpt. on thermoelectric generator, 1/1–3/30/62, 17: 4638 (AD-274164)
**HENNIG, G. R.**, Electron microscopy of graphite containing B, 17: 4956
**HEPNER, W. A.**, Inhomogeneous Lorentz group, 17: 5229
**HERBST, R. F.**, Detection of nuclear explosions, 17: 5061
**HERRMANN, W.**, Distribution of $\beta$ substances on surfaces, 17: 4757
**HESS, Bernard**, Pocket dosimeter, 17: 4869
**HESS, Friedhelm**, Reticuloendothelial system after radiation injury, 17: 4422
**HESS, W. N.**, Variations of inner radiation zone, 17: 5186
**HESS, Wilmot N.**, Energetic particles in inner Van Allen belt, 17: 5195
**HEYSSEL, R.**, Leukemia survivors in Hiroshima, 17: 4399
**HIBDON, C. T.**, Neutron background due to Ta backings for Li targets, 17: 5348
**HIDAKA, Y.**, Effect of x irradiation on mice, 17: 4413
**HIGGINS, C. E.**, Interactions between TBP, H$_3$PO$_4$, and water, 17: 4454
**HILL, Douglas G.**, Final rpt. on thermodynamic properties of fused salts, 1962, 17: 4496 (TID-17367)
**HILL, H. L.**, Minimizing downtime of power reactors, 17: 5609
**HILL, N. A.**, Deformation of Be under complex stressing, 17: 4970
**HILLARY, J. J.**, Recovery of Pa-231 from U waste, 17: 4632
**HIRAHARA, Eijo**, Isomer shift of Fe-57, 17: 5111
**HIRAI, Masamitsu**, Luminescence of x-rayed alkali halide, 17: 5112
**HIROTA, Noboru**, Spin distribution in ketyl radicals, 17: 4535
**HITCHCOCK, J. A.**, Heat transfer along fuel cans, 17: 4667
**HODGSON, P. E.**, Scattering of He-3 particles by N-14 and O-16, 17: 5363
**HODGSON, P. E.**, Scattering of He-3 particles by C, F, S, and Br, 17: 5364
**HODGSON, P. E.**, Variation of absorbing part of optical potential, 17: 5398
**HOERING, T. C.**, Physical chemistry of isotopic substances, 17: 4511
**HOFFMAN, R. A.**, Van Allen outer radiation regions, 17: 5184
**HOFFMAN, William C.**, Low-frequency waves in hydromagnetic medium and geomagnetic micropulsations, 17: 5433 (D1-82-0150)
**HOGG, B. G.**, Positron annihilation in solid cyclohexane, 17: 4567
**HOGG, James Finston**, Radiation-measuring equipment, 17: 4866
**HOGG, Kenneth**, Improvements in nuclear reactors, 17: 5598
**HOLLANDER, J. M.**, Properties of levels of Fm-254, 17: 5330
**HOLMES, D. K.**, Solid state theory, 17: 5036 (ORNL-3364(p.1-26))
**HOLMES, J. E. R.**, Physics problems of water reactors, 17: 5585
**HOLMES, John**, Scrub tower removes halogen off-gases, 17: 5648
**HOLMGREN, H. D.**, Angular correlations for $C^{12}(He^3,\alpha\gamma)C^{11}$, 17: 5372
**HOLT, O.**, Cosmic noise absorption, 17: 5092
**HOLTZ, F. C.**, Prog. rpt. on V alloys, 9/18–11/17/62, 17: 4924 (ARF-

B231-7)
**HONDA, Masatake**, Spallation products in Fe target, 17: 5336
**HONDA, Y.**, Effects of x-irradiation on hematopoietic system, 17: 4398
**HONIG, J. M.**, Galvano-thermomagnetic energy conversion devices. I., 17: 5080
**HONIG, J. M.**, Galvano-thermomagnetic energy conversion devices. II., 17: 5081
**HOOD, Donald W.**, Activation analysis of Mn and Zn in sea water, 17: 4469
**HOOD, Donald W.**, Pure aragonite synthesis, 17: 4540
**HOOK, J. L.**, Cosmic noise absorption, 17: 5092
**HOOPER, G. W.**, Self-diffusion in molten alkali halides, 17: 4513
**HORIZAWA, H.**, Radiation sensitivity of blood cells, 17: 4405
**HORN, D.**, Inclusion of leptons in isospace, 17: 5266
**HORNING, S. C.**, Elementary particles, 17: 5215
**HORROCKS, D. L.**, Tritium in fission of U-235, 17: 5337
**HOSEMANN, Rolf**, Pocket dosimeter, 17: 4869
**HOSTERMAN, E. F.**, Radiation grafting of chloromethylstyrene to polypropylene, 17: 4590 (TID-7643(p.345-97))
**HOTTEL, H. C.**, Measuring plasma jet temperatures, 17: 5443 (WADD-TR-60-676(Pt.II))
**HOVENIER, J.**, Scattering of 14.8-Mev neutrons from C and Bi, 17: 5359
**HOWE, D. A.**, Beta spectrum of Mn-56, 17: 5387
**HOWE, Henry F.**, Occupational exposure to ionizing radiation, 17: 4395
**HSIA CHEN, Catherine S.**, Radiation grafting of chloromethylstyrene to polypropylene, 17: 4590 (TID-7643(p.345-97))
**HSIEH, Kai-tee**, Oxidation potential of cerous–ceric electrode, 17: 4539
**HUANG, Kerson**, Method to measure lifetime of $\Sigma^0$ hyperon, 17: 5245
**HUB, Kenneth A.**, Nuclear reactor control system, 17: 5603
**HUBACH, R. A.**, Neutralization of ion beams, 17: 5647
**HUBBARD, Edward L.**, Heavy-ion accelerators, 17: 5062
**HUBER, Rudolf**, Antioxidants and survival rate of irradiated mice, 17: 4442
**HUBER, Rudolf**, Radiation protection. Tabular survey, 17: 4430
**HUCKE, Edward E.**, Mobilities in liquid Bi alloys, 17: 4946
**HUDSON, R. G.**, Final rpt. on carbides for thermionic space reactors, 5/15–8/31/62, 17: 5577 (GA-3523)
**HUET, J. J.**, Nickel as diffusion barrier between U and Al, 17: 4926 (EUR-17.f)
**HUGHES, W.**, Radiation hazards in x-ray analysis, 17: 4748
**HULM, J. K.**, High-field superconducting solenoid, 17: 4781
**HULTQVIST, B.**, Cosmic noise absorption, 17: 5092
**HUMMEL, Dieter**, Radiation-induced polymerization of vinyl monomers, 17: 4596
**HUMPHREY, W. R.**, Pressure transducer evaluation report, 17: 4795
**HUNGERFORD, H. E.**, Tables of secant integrals, 17: 4881
**HUNT, J. G.**, Prog. rpt. on dies for extrusion of steels and refractory alloys, 6/15/62–9/15/62, 17: 4911 (NMI-9700.3)
**HUNTER, C. L. F.**, Sterilization of syringes, 17: 4764
**HURLEY, P. M.**, Geochronology by Sr isotope variations, 17: 4706
**HUTCHISON, Clyde A., Jr.**, Resonance in triplet molecules, 17: 4532
**HUXTABLE, G. B.**, Efficiencies for detecting neutrons in organic scintillators, 17: 4836
**HYNDS, R. J.**, Particle flux produced by high-altitude explosion, 7/9/62, 17: 5115

# I

**ICHIKAWA, Yoshi H.**, Theory of resonance probe, 17: 5511
**ICHIMARU, Setsuo**, Wave properties of plasma, 17: 5471
**IDDINGS, C. K.**, Λ-Nucleon scattering and pion-hyperon coupling constants, 17: 5247
**IKAWA, Hyo**, Gamma-induced conductivity of CdSe, 17: 5005
**IKEDA, Takuro**, Ternary system $PbO-TiO_2-ZrO_2$, 17: 4963
**IKEGAMI, Hideo**, Theory of resonance probe, 17: 5511
**ILAKOVAC, K.**, Reaction $V^{51}(n,d)Ti^{50}$ at 14.4 Mev, 17: 5385
**ILIESCU, C.**, Triggering and adjustments of betatron, 17: 5414
**IMAEDA, K.**, Jets based on fireball model, 17: 5231
**IMHOFF, D. H.**, High power density BWR development, 17: 5624
**INGARD, Uno**, Instabilities of liquid conductor, 17: 4681
**INGOLD, J. H.**, Diffusion of electrons in scattering medium, 17: 5241
**INGRAHAM, R. L.**, Tacit uniqueness postulate in quantum field theory, 17: 5121
**INMAN, Robert M.**, Temperature distribution in laminar tube flow, 17: 4665
**INOUE, T.**, Radiation hygiene in U mines, 17: 4747
**IONESCU-PALLAS, N. J.**, Relativistic equation for hyperfine structure, 17: 5050
**ISHII, Keishi**, Spatial confinement of plasma, 17: 5475
**ISHIZUKA, Takeo**, Photoprotons from Al, 17: 5340
**ITO, Atsuko**, Isomer shift of Fe-57, 17: 5111
**ITO, Chuko**, Production of $UF_4$ from U raw material, 17: 4624
**IVANITSKII, A. M.**, Sensitivity to pharmacological substances, 17: 4438
**IVASCU, M.**, Neutron scattering on S-32 at 4.6 Mev, 17: 5327

# J

**JACKSON, E. Atlee**, Nonlinear coupled oscillators. I., 17: 4770 (MATT-95)
**JACKSON, W. M.**, Reaction of methyl-$d_3$ radicals with isobutane, 17: 4562
**JACOBSON, M. I.**, Surface damage in Be, 17: 4937
**JAGIELSKI, Aleksy**, Contamination of grass by Sr-90, 17: 4392
**JAIN, R. K.**, Laminar hydromagnetic flow in porous-wall annulus, 17: 5467
**JAMRACK, William Douglas**, Methods of recovering Pu, 17: 4636
**JANAREK, F. J.**, Operation of Li-drifted Si junction detectors, 17: 4832
**JANAUER, G. E.**, Determination of Th with Eriochrome Black T, 17: 4471
**JANAUER, G. E.**, Determination of microgram quantities of U(VI), 17: 4477
**JANAUER, G. E.**, Spectrophotometric determination of Th and U, 17: 4476
**JANKIEWICZ, Cz.**, Electromagnetic field in Riemannian space, 17: 5537
**JANKIEWICZ, Cz.**, Mass tensor of non-relativistic hydrodynamics, 17: 5536
**JAY, K. E. B.**, DIDO research reactor and use, 17: 5636
**JEAN, A. G.**, Ionospheric effects of solar flare, 17: 5101
**JEDRZEJEWSKI, W.**, Mechanism of oxidation of $I^-$ ions, 17: 4598
**JEFFERY, Derek Boyd**, Shock absorbing devices for moving bodies, 17: 5601
**JEFFREY, G. A.**, Applications of nuclear quadrupole resonance, 17: 4443 (AFOSR-2542)
**JENKINS, E. W.**, Elastic p-p cross sections, 17: 5258
**JENKINS, Edward B.**, Geomagnetic field, solar wind interface, 17: 5174
**JENKINS, R. G.**, Prog. rpt. on dies for extrusion of steels and refractory alloys, 6/15/62–9/15/62, 17: 4911 (NMI-9700.3)
**JENNINGS, D. A.**, Interruption of nuclear spin diffusion, 17: 4531
**JENSEN, T. H.**, Interaction between plasma and external current and flux, 17: 5504
**JENSEN, W. P.**, Measuring plasma jet temperatures, 17: 5443 (WADD-TR-60-676(Pt.II))
**JERONYMO, J. M. F.**, Lithium-6(d,α)α reaction, 17: 5322 (NP-12258)
**JETER, Thomas R.**, Preliminary assignment of Si-28 excited states, 17: 5321 (BRL-Memo-1392)
**JEŻOWSKA-TRZEBIATOWSKA, B.**, Mechanism of oxidation of $I^-$ ions, 17: 4598
**JOHANSSON, Sven A. E.**, Spontaneous fission of heaviest elements, 17: 5326 (UCRL-10474)
**JOHNSON, John L.**, Equilibrium and stability for systems with small curvature, 17: 5438 (MATT-89)
**JOHNSON, William B.**, Pion-pion interactions, 17: 5252
**JOLY, R.**, Determination of thermal neutron absorption, 17: 5319
**JONES, C. Miller**, Phase-shift analysis of scattering of protons from O, 17: 5355
**JONES, Eric D.**, Zeeman modulator for NQR spectroscopy, 17: 4794
**JONES, H. F.**, Deuteron form factor and elastic e-d scattering, 17: 5237
**JONES, L. V.**, Density of molten Pu, 17: 4944
**JONES, Llewellyn H.**, Molecular-orbital approach to development of vibrational potential functions, 17: 5108
**JONES, O. E.**, Explosively loaded metals yield behavior, 17: 4949
**JONES, R. Clark**, Information capacity of radiation detectors. II., 17: 4822
**JONES, Roger C.**, Gaseous plasma lens, 17: 4803
**JONKER, C. C.**, Scattering of 14.8-Mev neutrons from C and Bi, 17: 5359
**JOPSON, R. C.**, L-shell fluorescence yields of Pt, Tl, and Pb, 17: 5135
**JOUVET, B.**, Anomalous properties of vector fields, 17: 5226
**JOVANOVIC-KOVACEVIC, Olga**, Radioactive P-32, 17: 4616

# K

**KAGAMI, M.**, Radiation hygiene in U mines, 17: 4747

**KAGARISE, R. E.**, Properties of Ce and Fe compounds, 17: 4450
**KAGEYAMA, Kosuke**, Giant resonance in $Al^{27}(\gamma,n)$, 17: 5341
**KAGEYAMA, Kosuke**, Reactions $P^{31}(\gamma,n)$ and $S^{32}(\gamma,n)$, 17: 5342
**KAHN, Milton**, Bibliographies on isotopic exchange reactions, 17: 4494 (SCR-512)
**KAHN, Peter B.**, Field theories with one-particle states. I., 17: 5571
**KALBACH, R. M.**, Proton-proton collisions at 19.8 Bev/c, 17: 5236
**KALECIŃSKI, J.**, Mechanism of oxidation of $I^-$ ions, 17: 4598
**KALINOVA, M. V.**, Absorption of electrolytes on $ZrO_2$, 17: 4500 (AEC-tr-5529)
**KALVIUS, M.**, Hyperfine structure splitting of $\gamma$ lines. V., 17: 5406
**KAMEI, Osamu**, Multiple production of particles, 17: 5399
**KANAZAWA, Akira**, Electromagnetic form factors of nucleon, 17: 5274
**KANG, Ik-Ju**, Coulomb scattering of spinless particle, 17: 5558
**KANTELE, J.**, Gamma spectrometry with sum-peak coincidence spectrometer, 17: 4828
**KAPLYANSKII, A. A.**, Spectra of Eu by Yb in fluorides, 17: 4547
**KARELIN, V. V.**, Vapor pressure of Y, 17: 4515
**KARPLUS, R.**, Analyticity and unitarity general transition amplitudes, 17: 5547
**KARZAS, W. J.**, Interaction of nuclear explosions with magnetic field, 17: 5099
**KASHA, Henry**, Cherenkov radiation from extensive air showers, 17: 5197
**KASHCHEEV, V. N.**, Magnetovibrational scattering of slow neutrons, 17: 5318
**KATO, Riso**, Spatial confinement of plasma, 17: 5475
**KATZ, J. J.**, Denaturation of deuteriated DNA in $H_2O$ and $D_2O$, 17: 4389
**KATZMAN, J.**, Intensity level of cosmic rays in Canada, 17: 5180
**KAUFMAN, Allan N.**, Macroscopic electrostatic and magnetostatic energy, 17: 5203 (UCRL-6499)
**KAWAI, Hiroshi**, Liquid scintillation counter, 17: 4824
**KAWAMATSU, Shunzi**, Graft polymerization by pre-irradiation, 17: 4607
**KAWCYN, R. A.**, Thermal and radiative properties of recombining atomic N, 17: 5132
**KAZANSKII, V. B.**, Hydrogen atoms formed in silica gel by irradiation, 17: 4615
**KEDDY, R. J.**, Lifetimes of first excited states of $Li^7$ and $Na^{23}$, 17: 5386
**KEDER, W. E.**, Amines as extractants—organic phase, 17: 4626 (HW-SA-2797)
**KEITH, James E.**, Radioactivity induced in Discoverer 17, 17: 5098
**KELLER, Joseph B.**, Dispersion equation for plasma, 17: 5470
**KELLER, W. E.**, Cryogenics, 17: 5065
**KELLERS, C. F.**, Melting curves of $He^3$–$He^4$ mixtures, 17: 5144
**KELLY, B. T.**, Dimensional changes in graphite, 17: 5008
**KEMENY, G. A.**, Forced-convective flow in vertical tubes, 17: 4673
**KEMP, E. L.**, Energy storage capacitor banks, 17: 4645
**KEMP, M. A. R.**, Charged $\pi$ meson production in p-p collisions, 17: 5199 (AERE-R-3969)
**KENDALL, P. W.**, Electron transport in liquid Ga, 17: 4975
**KENDALL, W. B.**, Thermodynamic properties of U gas, 17: 4521
**KENNA, B. T.**, Search for Tc in nature, 17: 4449
**KENNETT, Leslie Proffitt**, Improvements in electrolytic cells, 17: 4655
**KENNETT, Leslie Proffitt**, Improvements in electrolytic cells, 17: 4656
**KENT, J. A.**, Preparation of wood–plastic combinations using radiation, 17: 4589 (TID-7643(p.335-44))
**KEPP, Richard**, Pregnancies after action of radiation on gonads, 17: 4423
**KERN, J. W.**, Production of polar auroras and electrojets, 17: 5043 (RM-3058-NASA)
**KERNS, Quentin A.**, Transistors for avalanche-mode operation, 17: 4651
**KERRIGAN, M. A.**, Airborne radioactivity from weapons tests, 17: 4746
**KIENLE, P.**, Hyperfine structure splitting of $\gamma$ lines. V., 17: 5406
**KIKUCHI, Atsushi**, Dielectric constant of Sr titanate, 17: 4960
**KILLEEN, J.**, Plasma production by neutral-atom injection, 17: 5473
**KIM, Chong Kuk**, Analysis of Ta and Nb by neutron activation, 17: 4481
**KIM, Y. S.**, Polarization of high-energy photoprotons from light elements, 17: 5389
**KIMURA, Motoharu**, Giant resonance in $Al^{27}(\gamma,n)$, 17: 5341
**KIMURA, Motoharu**, Reactions $P^{31}(\gamma,n)$ and $S^{32}(\gamma,n)$, 17: 5342
**KIMURA, Yoshiko**, NMR of Fe-57 in Li ferrite and magnetite, 17: 5113
**KIND, A.**, Coolant temperature coefficient and group diffusion model, 17: 5306
**KING, C. D.**, Prog. rpt. on organic coolants, 4/1–5/30/62, 17: 5578 (IDO-11002)
**KING, J. I. F.**, Steady-state electron densities for irradiated plasmas, 17: 5437 (GCA-TR-62-8-A)
**KINOSITA, Kozo**, Adsorption of $H_2O$ on LiF, 17: 4545
**KIRCHENMAYER, A.**, Moderator slowing down properties, 17: 5314
**KIRCHER, J. F.**, Grafting of vinyl pyrrolidone to polymethylmethacrylate by pre-irradiation techniques. I., 17: 4580 (TID-7643 (p.185-98))
**KIRK, J.**, Scattering of He-3 particles by C, F, S, and Br, 17: 5364
**KIRKPATRICK, A. R.**, Commissioning Bradwell No. 1 reactor, 17: 5587
**KIRSTEN, F. A.**, Acoustic spark chamber, 17: 4829
**KIRTMAN, Bernard**, Polarizability change in liquids, 17: 4526
**KITAGAWA, O.**, Radiation-induced heterogenous lethal factor, 17: 4434
**KITANO, Yasushi**, Pure aragonite synthesis, 17: 4540
**KITTEL, J. H.**, Performance on Al–U alloy fuel plates, 17: 5023
**KLABUNDE, C. E.**, Reactor damage in pure metals, 17: 5001
**KLEIN, Claude A.**, Pyrolytic graphites as semimetallic solids, 17: 4891
**KLEIN, G.**, Magnetohydrodynamics seen by manufacturer, 17: 5526
**KLINGENSMITH, R. W.**, Energy spectrum of fission fragments from $UO_2$, 17: 5085
**KLODT, Donald T.**, Prog. rpt. on oxidation resistance of $NbAl_3$, 9/61–8/62, 17: 4902 (DRI-2061)
**KLODT, Donald T.**, Prog. rpt. on oxidation resistance of $NbAl_3$, 9/62–11/62, 17: 4903 (DRI-2075)
**KNIGHT, James A., Jr.**, Prog. rpt. on radiation-induced cyanogenation of organic compounds, 7–9/62, 17: 4993 (TID-17266)
**KNIGHTS, Herbert Chilvers**, Improvements in coupling devices, 17: 4653
**KNITTNER, G.**, Ion source of inverse-magnetron type, 17: 5423
**KNOFF, Joergen Bomhoft**, Ionized gases in electromagnetic fields, 17: 5531 (AFCRL-62-281)
**KNORR, T. G.**, Fission tracks in AgCl crystals, 17: 5082
**KNOTT, David H.**, Radioprotective effects of Br·HBr (AET), 17: 4440
**KNOX, R. S.**, Screening correction to Slater exchange potential, 17: 5147
**KOBAYASHI, Riki**, Diffusion of Kr-85 in dense gases, 17: 4524
**KOBAYASHI, Tetsuro**, Multiple production of particles, 17: 5399
**KOCH, H.**, Liquid scintillation counter for C-14 compounds, 17: 4821
**KOCH, R.**, Hyperfine structure splitting of $\gamma$ lines. V., 17: 5406
**KOCH, Robert B.**, Resistance of *Clostridium botulinum* to $\gamma$ rays, 17: 4394
**KODERA, Yoichi**, Dielectric constant of Sr titanate, 17: 4960
**KOEHLER, W.**, Neutron flux in FRM reactor, 17: 5635
**KOEHLER, W. C.**, Neutron diffraction, 17: 5059
**KOGA, Toyoki**, Interaction between radio wave and high-temperature plasma, 17: 5501
**KOHN, H. W.**, Surface properties of silica gel, 17: 5026
**KOJIMA, Hiroomi**, Adsorption of $H_2O$ on LiF, 17: 4545
**KOJIMA, Masaki**, Luminescence of x-rayed alkali halide, 17: 5112
**KOLAR, Jaromir**, Calcium metabolism after x irradiation. III., 17: 4425
**KOLBER, Stanislaw**, Two-channel regulating delay system, 17: 4785
**KOLLIE, T. G.**, Thermal conductivity of INOR-8, 17: 4942
**KOLTHOFF, I. M.**, Uranium, 17: 4485
**KOMAROV, V. V.**, Decay of C-12 caused by $\alpha$ particles, 17: 5361
**KOMATUZAKI, Takesi**, Protons from several elements, 17: 5339
**KONIJN, J.**, Half life of He-6, N-16, O-19, F-20, Al-28, Se-77m, and Ag-110, 17: 5352
**KON'KOV, A. S.**, Heat transfer during boiling in tubes, 17: 4663 (AEC-tr-5539)
**KONSTANTINOV, B. P.**, Exchange between Li–K, Li–Na, and Li–Cs, 17: 4635
**KOPAL, Zdenek**, Internal constitution of the moon, 17: 4378
**KOPP, H. J.**, Solution of transport equation, 17: 5302 (TID-15404)
**KOPP, Harold J.**, Applications of synthetic method, 17: 5303 (TID-15405)
**KOPPEL, Juan**, Diffusion hardening in water, 17: 5308
**KORENBLIT, I. Ya.**, Kinetic equation for impurity scattering of electrons, 17: 5282
**KORKISCH, J.**, Determination of Th with Eriochrome Black T, 17: 4471
**KORKISCH, J.**, Determination of microgram quantities of U(VI), 17: 4477
**KORKISCH, J.**, Separation of U, Th, and Bi, 17: 4478
**KORKISCH, J.**, Spectrophotometric determination of Th and U, 17: 4476
**KOSTENKO, M. S.**, Phagocytosis in radiation sickness, 17: 4402
**KOSTYRKO, Andrzej**, Producing ZnS scintillator for $\alpha$ detector, 17: 4847
**KOSTYRKO, Andrzej**, Producing standard radioactive sources for calibrating dosimeters, 17: 5009

**KOTTWITZ, D. A.**, Quasi-elastic scattering by $H_2O$, 17: 5297 (HW-75147)
**KOWALSKI, E.**, Measurement of air radioactivity, 17: 4814
**KOWALSKI, Ludwik**, Semiconductor junction barrier detectors, 17: 4849
**KOYAMA, Masaki**, Liquid scintillation counter, 17: 4824
**KRALL, Nicholas A.**, Trapping instabilities in inhomogeneous plasma, 17: 5486
**KRAUSHAAR, J. J.**, Nuclear magnetic dipole moment of Ca-41, 17: 5390
**KRAYBILL, H. L.**, Interactions in $\pi^+$-p collisions, 17: 5279
**KRAYBILL, H. L.**, Properties of the $\eta$ meson, 17: 5259
**KRESGE, A. J.**, Aromatic H exchange in methoxybenzenes, 17: 4560 (TID-17369)
**KRESSIN, Ivan K.**, Separation of Pu by anion exchange, 17: 4629
**KRIZAN, John E.**, Corrections in statistical mechanics of interacting particles, 17: 5564
**KROHN, Victor E., Jr.**, Negative ions from surfaces bombarded by positive Cs ions, 17: 5087
**KROKOWSKI, Ernst**, Radiation protection for lens of eye, 17: 4441
**KROLIKOWSKA-PRASAL, Irena**, Irradiation of nervous system of Albino rats, 17: 4393
**KROMMINGA, A. J.**, Perturbation theory of many-boson systems, 17: 5561
**KROPP, John L.**, Quenchers in organic scintillator solutions, 17: 4563
**KROPP, John L.**, Quenchers in organic scintillator solutions, 17: 4564
**KRUEGER, Helmut H. A.**, Radiation damage and ferroelectric effect in Rochelle salt, 17: 5003
**KUBO, Hiroshi**, Negative radiation temperature at resonance in cold plasmas, 17: 5461
**KUCHOWICZ, B.**, Operators of homogeneous Lorentz group. II., 17: 4879
**KUKACKA, L.**, Gamma polymerization of ethylene, 17: 4574 (TID-7643 (p.70-106))
**KUMABE, Isao**, Protons from several elements, 17: 5339
**KUNSTADT, E.**, Autoinfection after total-body lethal irradiation, 17: 4433
**KUO, L. G.**, Reaction $V^{51}(n,d)Ti^{50}$ at 14.4 Mev, 17: 5385
**KUPFERBERG, Kenneth M.**, Lifetime of neutrons in reflectors, 17: 5299 (LA-2743)
**KURI, Z.**, ESR of electron-irradiated cycloheptatriene, 17: 4604
**KURIYAMA, Katsumi**, Cross sections of $Cl^{35}(\gamma,n)Cl^{34}$ and $S^{32}(\gamma,n)S^{31}$, 17: 5344
**KURODA, P. K.**, Dating methods based on fission, 17: 4707
**KURODA, P. K.**, Formation of solar system. I., 17: 5171
**KURODA, P. K.**, Formation of the solar system. II., 17: 5172
**KUSCER, I.**, Reciprocity theorems for thermal neutrons, 17: 5304
**KUTIKOV, I. Y.**, Neutrons emitted by U-236 in symmetric fission region, 17: 5351

## L

**LABSOVSKII, L. N.**, Exchange in adiabatic approximation in atom theory, 17: 5156
**LACH, Joseph**, Pion-pion interactions, 17: 5252
**LACOMBE, Paul**, Structure heredity between $\beta$ and $\alpha$ phases of Co, 17: 4948
**LAI, Tsai-Teh**, Cathodic action of the U chelate compounds. II., 17: 4538
**LAKNER, JOHN F.**, Uranium hydride melting, 17: 4512
**LAMBORN, B. N. A.**, Two-stream instability, 17: 5441 (TID-17370)
**LANCZOS, C.**, Splitting of the Riemann tensor, 17: 5568
**LAND, R. I.**, Poiseuille plasma experiment, 17: 5494
**LANDMARK, B.**, Cosmic noise absorption, 17: 5092
**LANDSBERG, H. E.**, Advances in Geophysics, Vol. 9, 17: 4703
**LANE, James A.**, Atomic energy in industrial development, 17: 4377
**LANES, Stephen J.**, Multiplication factors for bare cylinders, 17: 5198 (HASL-124)
**LANGER, L. M.**, Beta spectrum of Mn-56, 17: 5387
**LANGHANS, Kurt**, Radiation-measuring apparatus, 17: 4859
**LANGSFORD, A.**, Efficiencies for detecting neutrons in organic scintillators, 17: 4836
**LANNOY, Fr. G.**, Conserved and partially conserved currents, 17: 5219
**LAPIN, B. A.**, Influence of radiation on immunity to measles, 17: 4401
**LA PLANTE, J. P.**, Oxidized complex of Ni, 17: 4506
**LARSEN, W. L.**, Thorium–V phase diagram, 17: 4936
**LASHKO, A. S.**, X-ray studies of liquid In alloys with Pb and Sn, 17: 4977
**LASHKO, N. F.**, Brazing and soldering of metals, 17: 4917
**LASHKO-AVAKYAN, S. V.**, Brazing and soldering of metals, 17: 4917
**LASSEN, N. O.**, Alpha-induced fission of Ne-20, 17: 5368
**LASSEN, N. O.**, Alpha-induced fission of Si-28, 17: 5369
**LATTER, R.**, Detection of nuclear explosions, 17: 5061
**LATTER, R.**, Interaction of nuclear explosions with magnetic field, 17: 5099
**LAUBENSTEIN, R.**, Prog. rpt. on thermionic converter, 1–3/62, 17: 5637 (AD-275908)
**LAUGHLIN, C. D.**, Electrons in outer radiation zone, 17: 5183
**LAURO, Michele**, Post-irradiation experience on irradiated U samples, 17: 4993
**LAVAKARE, P. J.**, Tritons and deuterons in primary cosmic radiation, 17: 5189
**LAVERLOCHERE, J.**, Neutron activation analysis of Na, 17: 4482
**LAVIN, M. L.**, Heat transfer in rarefied gas, 17: 4680
**LAWROSKI, S.**, State nuclear technology, 1/62, 17: 4376 (TID-14912)
**LAWSON, Donald Wilfred**, Improvements in reactors, 17: 5595
**LAYMAN, Robert W.**, Production of hot rotating plasma, 17: 5492
**LEBEDEV, V. I.**, Neutrons emitted by U-236 in symmetric fission region, 17: 5351
**LE CLERC, Pierre Georges**, Measurement of flux of neutrons, 17: 4864
**LEDDICOTTE, G. W.**, Radioactivation analysis, 17: 4484
**LEDERER, M.**, Separation of inorganic ions by electrophoresis, 17: 4467
**LEE, D. M.**, Melting curves of $He^3$–$He^4$ mixtures, 17: 5144
**LEE, James P.**, Changes in earth magnetic field from high-altitude explosion, 7/9/62, 17: 5106
**LEE, Therese C.**, Effects of x radiation on phospholipid metabolism. I., 17: 4419
**LE FEBRE, V.**, Gamma-induced defects in single-crystal $\alpha$-$Al_2O_3$, 17: 4997
**LEHRER, Y.**, Fuel temperature increase following "loss of coolant" accident, 17: 5583
**LEIBOVICI, I.**, Triggering and adjustments of betatron, 17: 5414
**LEINBACH, H.**, Cosmic noise absorption, 17: 5092
**LEININGER, R. I.**, Grafting of vinyl pyrrolidone to polymethylmethacrylate by pre-irradiation techniques. I., 17: 4580 (TID-7643 (p.185-98))
**LENGEROVA, Alena**, Transplantation therapy in lethally irradiated mice, 17: 4432
**LENZ, H.**, Age determination of U minerals, 17: 4710
**LEONARD, B. R., Jr.**, Quasi-elastic scattering by $H_2O$, 17: 5297 (HW-75147)
**LEONTIC, B.**, DISC: Cherenkov counter with velocity selection, 17: 4826
**LEONTIC, B.**, DISC counter with liquid radiator, 17: 4827
**LEPARD, D. W.**, Raman spectrum of ethane-$d_6$, 17: 5073
**LEVINE, A. D.**, Spin of the phonon, 17: 5120
**LEVINE, E. D.**, Al–Li phase diagram, 17: 4930 (NMI-7010)
**LEVINE, M. A.**, Betatron potential wells, 17: 5421
**LEVINGER, J. S.**, Analysis of electron-proton scattering, 17: 5239
**LEVSHIN, V. L.**, Flash mechanism of SrS phosphors, 17: 5049 (UCRL-Trans-853(L))
**LEVY, Maurice**, Radiative corrections and elementary nature of photons, 17: 5263
**LEVY, S.**, High power density BWR development, 17: 5624
**LEWELLEN, W. S.**, Comment on "Flow of an incompressible fluid in a hydromagnetic capacitor", 17: 4682
**LEWIS, Robert M.**, Dispersion equation for plasma, 17: 5470
**LEY, Gregor**, Radiation-induced polymerization of vinyl monomers, 17: 4596
**LI, Sen-gi**, Diffusion coefficients in $SrCl_2$ solutions, 17: 4549
**LIBBY, W. F.**, Industrial uses of isotopes, 17: 5064
**LIEBERMAN, R.**, Grafting of vinyl pyrrolidone to polymethylmethacrylate by pre-irradiation techniques. I., 17: 4580 (TID-7643 (p.185-98))
**LIKENS, Gene Elden**, Transport of radioisotopes in lakes, 17: 4715
**LIMIC, N.**, Scattering on highly singular potentials, 17: 5553
**LIN, S. H.**, Laminar heat transfer in tubes, 17: 4676
**LIN, Shao-Chi**, Ionization behind shock waves in air. I., 17: 5131
**LINCOLN, John William**, Control of steam turbine plants, 17: 4686
**LINDEN, Bernard R.**, Neutron detector, 17: 4868
**LINDENBAUM, S. J.**, Shielding of high-energy accelerators, 17: 5057
**LINDGREN, Stig**, Direction of the cosmic ray anisotropy, 17: 5196
**LINDSKOG, J.**, Lifetime of 129-kev level in Ir-191, 17: 5408
**LINDSTROM, Olle**, Fuel composition for aqueous homogenous reactors,

17: 5605

**LIPPMANN, B. A.,** Uniqueness and rearrangement collisions, 17: 5204 (UCRL-6558-T)

**LIPSCHULTZ, F. P.,** Melting curves of $He^3$–$He^4$ mixtures, 17: 5144

**LIPSCOMB, E. T.,** Interaction of microwaves with exploding wires, 17: 5480

**LISTENGARTEN, M. A.,** Two quantum transitions of nuclei, 17: 5405

**LITTLE, R. C.,** Heat transfer in outgassed powders, 17: 4668

**LITTMAN, T. M.,** Final prog. rpt. on compatibility of materials with K, 4/60–12/61, 17: 4905 (NP-12334)

**LIU, F. F.,** Polarization of high-energy photoprotons from light elements, 17: 5389

**LIU, Shen-fu,** Spectra of alkali earth metal fluorides, 17: 5125

**LOEFFLER, F. J.,** Polarization of high-energy photoprotons from light elements, 17: 5389

**LOENSJOE, O.,** Resonance widths for proton capture—graphical method, 17: 5346

**LOEWDIN, Per-Olov,** Constants of motion in quantum mechanics, 17: 5573

**LOEWENSTEIN, P.,** Prog. rpt. on dies for extrusion of steels and refractory alloys, 6/15/62–9/15/62, 17: 4911 (NMI-9700.3)

**LOEWY, Robert Gustav,** Hydromagnetic shocks in cold plasma, 17: 5517

**LOFERSKI, J. J.,** Radiation defect introduction rates in n- and p-type Si, 17: 5015

**LOH, E. C.,** Decay of $K^+$, 17: 5202 (TID-14840)

**LOKEN, Merle K.,** Effects of x radiation on phospholipid metabolism. I., 17: 4419

**LOTKOVA, E. N.,** Spectrum of Si irradiated by fast neutrons, 17: 5010

**LOTT, J.,** Bladder tumors after radiation therapy, 17: 4385

**LOUTHAN, M. R., Jr.,** Tensile properties of Zy with oriented hydrides, 17: 4932 (TID-17372)

**LOVELACE, C.,** Regge poles by continued fractions. I., 17: 5550

**LOW, Charles A., Jr.,** Electrostatic propulsion system with nuclear electrogenerator, 17: 5645

**LOW, W.,** Paramagnetic resonance of rare earth ions, 17: 5030 (AFOSR-2114)

**LOWES, Leonard,** Improvements in mixer-settler, 17: 4797

**LOWREY, Girard R., Jr.,** Gaseous plasma lens, 17: 4803

**LUCCHESI, P. J.,** Solubility of $SrSO_4$ in water, 17: 4466

**LUEST, R.,** Stability of plasma torus not dependent on azimuth, 17: 5440 (TID-13633)

**LUISADA, August G.,** Shield for ionizing radiation, 17: 5529

**LUNDBY, A.,** DISC: Cherenkov counter with velocity selection, 17: 4826

**LUNDBY, A.,** DISC counter with liquid radiator, 17: 4827

**LUNDGREN, G.,** Resonance integral of Nb, 17: 5320 (AE-81)

**LUNDIN, Charles E.,** Prog. rpt. on oxidation resistance of $NbAl_3$, 9/61–8/62, 17: 4902 (DRI-2061)

**LUNDQUIST, C. A.,** Mirror-point distributions of trapped particles, 17: 5182

**LUNGU, S. N.,** Properties of Zr and Hf halides, 17: 4501

**LYNCH, C. T.,** Phase transformation of $ZrO_2$, 17: 4519

**LYON, L. L.,** Intercalation of Co(II) chloride in graphite, 17: 4552

## M

**MAC DONALD, A. D.,** Electron diffusion in multimode cavity, 17: 5042 (RADC-TDR-62-67)

**MAC DONALD, D.,** Heat generation and transfer in reactors, 17: 5586

**MACHLAN, Lawrence A.,** Separation of Hf from Zr and determination, 17: 4633

**MACHWE, M. K.,** Scattering of 14-Mev neutrons from Mo, 17: 5393

**MACKINTOSH, A. R.,** Positron annihilation in solids, 17: 5200 (IS-299)

**MAGEE, Charles B.,** Prog. rpt. on transition-metal hydryls, 6–9/62, 17: 4925 (DRI-2065)

**MAGLIC, B. C.,** Acoustic spark chamber, 17: 4829

**MAIDANOVSKAYA, L. G.,** Absorption of electrolytes on $ZrO_2$, 17: 4500 (AEC-tr-5529)

**MAITLAND, A.,** Energy from Carnot engine with thermally ionized gas, 17: 5088

**MAKANSI, Munzer M.,** Vapor pressure of alkali metals, 17: 4947

**MAKIN, M. J.,** Fission fragment tracks in $UO_2$, 17: 4974

**MALMSKOG, S.,** Half life of He-6, N-16, O-19, F-20, Al-28, Se-77m, and Ag-110, 17: 5352

**MANCINELLI, Alberto,** Radioresistant mutant of *S. aureus*, 17: 4384

**MANCINI, M.,** Irradiation "factor-dependency" of vinyl monomers, 17: 4571 (TID-7643(p.1-16))

**MANI, G. S.,** Lithium-6(d,$\alpha$)$\alpha$ reaction, 17: 5322 (NP-12258)

**MANN, Dennis Charles MacMillan,** Radiation grafting of acrylonitrile, 17: 4619

**MANN, H. M.,** Operation of Li-drifted Si junction detectors, 17: 4832

**MANNING, G.,** Charged $\pi$ meson production in p-p collisions, 17: 5199 (AERE-R-3969)

**MANSER, W. C.,** Drying and calcining of raffinate, 17: 4630

**MANUEL, O. K.,** Formation of solar system. I., 17: 5171

**MARADUDIN, A. A.,** Scattering of neutrons by anharmonic crystal, 17: 5317

**MARIANA, F.,** Geomagnetic, auroral, ionospheric and cosmic ray disturbance, 17: 5047 (AD-275256)

**MARINI, G.,** Photoproduction of muon pairs in C, 17: 5260

**MARK, Hans,** Alpha-particle backscattering, 17: 5100

**MARK, Hans,** L-shell fluorescence yields of Pt, Tl, and Pb, 17: 5135

**MARKLE, R. A.,** Grafting of vinyl pyrrolidone to polymethylmethacrylate by pre-irradiation techniques. I., 17: 4580 (TID-7643 (p.185-98))

**MARKOWITZ, Meyer M.,** Lithium metal–gas reactions, 17: 4522

**MARONI, C.,** Internal Compton effect, 17: 5123

**MARQUART, J. R.,** Magnesium halides study, 17: 4530

**MARRUS, R. A.,** Atomic beams, 17: 5403

**MARSHALL, R. P.,** Tensile properties of Zy with oriented hydrides, 17: 4932 (TID-17372)

**MARSHALL, Thomas,** Thermal and radiative properties of recombining atomic N, 17: 5132

**MARTALOGU, N.,** Neutron scattering on S-32 at 4.6 Mev, 17: 5327

**MARTENSEN, E.,** Stability of plasma torus not dependent on azimuth, 17: 5440 (TID-13633)

**MARTIN, A.,** Scattering amplitude of two interactive particles, 17: 5227

**MARTIN, Alfred John,** Production of Be of increased ductility, 17: 4988

**MARTIN, D. G.,** Recovery in neutron-irradiated Au, 17: 5012

**MARTIN, W. H.,** Dimensional changes in graphite, 17: 5008

**MARTORELL, Jose Terrazo,** Micrographic study of metal deposits on incandescent filaments, 17: 4890

**MARWAHA, A. S.,** Electron transport in liquid Ga, 17: 4975

**MASIRONI, Roberto,** Radioresistant mutant of *S. aureus*, 17: 4384

**MASSON, D.,** Regge poles by continues fractions. I., 17: 5550

**MASTENBROEK, E.,** Decay of Gd-153, 17: 5392

**MATSUDA, Tasuo,** Gamma-induced graft copolymerization. IV., 17: 4608

**MATSUDAIRA, Noboru,** Interaction of plasmon with radiation. I., 17: 5458

**MATUMURA, On,** Gamma-induced conductivity of CdSe, 17: 5005

**MC CUE, James C.,** Soft $\gamma$ radiography with minimum hazard, 17: 4688

**MC DONALD, D. L.,** Reactor damage in pure metals, 17: 5001

**MC ELROY, D. L.,** Thermal conductivity of INOR-8, 17: 4942

**MC KEEVER, Richard,** Beam from duoplasmatron proton source, 17: 5153

**MC LATCHIE, W.,** Separation energies for isotopes of Sn and Sb, 17: 5333

**MC LAUGHLIN, A. G.,** Rocket for particulate sampling of clouds, 17: 4692 (UCRL-13054)

**MC LEAN, Donald,** Absence of Landau absorption in nonlinear treatment, 17: 5449

**MC LENDON, J. D.,** Tests of proposed U container, 17: 4745 (Y-KB-22)

**MC MASTERS, O. D.,** Thorium–V phase diagram, 17: 4936

**MC NAMEE, Raymond W., Jr.,** Matrix isolation studies of Group II chlorides, 17: 4497 (UCRL-10451)

**MC NESBY, J. R.,** Reaction of methyl-$d_3$ radicals with isobutane, 17: 4562

**MC TAGGART, John,** Control of steam turbine plants, 17: 4686

**MC VITTIE, G. C.,** Photon density and $\gamma$ flux in expanding universe, 17: 5177

**MC WILLIAMS, A. S.,** Phase separation in solid $He^3$–$He^4$ mixtures, 17: 5145

**MEDVED, D. B.,** Interaction of microwaves with exploding wires, 17: 5480

**MEDVED, D.B.,** Secondary electron emission from satellite surfaces, 17: 5644 (ZPh-084)

**MEGY, Jean,** Display device for cyclically checking values, 17: 4657

**MEHTA, K. N.,** Laminar hydromagnetic flow in porous-wall annulus, 17: 5467

**MEINKE, W. Wayne,** Activation analyses in marine organisms, 17: 4468

**MEINKE, W. Wayne,** Fast neutron activation analysis, 17: 4479

**MEISTER, H.,** Chain lengths for decay of U-235 fission products, 17: 5407

**MELEHAN, J. B.,** Fission-gas release from $UO_2$, 17: 4896

**MELVEGER, A. J.,** Vaporization and physical properties of refractories,

17: 4933 (WADD-TR-60-463(Pt.II))
**MELVIN, M. A.,** Elementary particles and symmetry principles, 17: 5280
**MENEGHETTI, David,** Quadratures for thin slab cells, 17: 5313
**MENGERT, Peter,** Relaxation of quantum mechanical systems, 17: 5532 (NP-12260)
**MENKES, J.,** Stability of shear layer in magnetic field, 17: 5484
**MERCIER, C.,** Stability of MHD equilibria, 17: 5521
**MERKLE, K. L.,** Fission-fragment tracks in films, 17: 5017
**MESRINE, R.,** Quasi one-dimensional flows in magnetohydrodynamics, 17: 5523
**METZGER, Albert E.,** Gamma rays in space, Ranger 3, 17: 5185
**MEUNIER, R.,** DISC: Cherenkov counter with velocity selection, 17: 4826
**MEUNIER, R.,** DISC counter with liquid radiator, 17: 4827
**MEYER, C. A.,** Working fluids for power generation, 17: 5628
**MEYER, Leon H.,** Analytical techniques for control of T, 17: 4455 (DP-771)
**MICKELSEN, William R.,** Electrostatic propulsion system with nuclear electrogenerator, 17: 5645
**MIHU, V. P.,** Electromagnetic wave absorption gases, 17: 5207
**MIKAELYAN, L. A.,** Neutrons emitted by U-236 in symmetric fission region, 17: 5351
**MILLER, Harold W.,** Transistors for avalanche-mode operation, 17: 4651
**MILLER, John H., III,** Positron decay of Sc-42, V-46, Mn-50, Co-54, and Cu-58, 17: 5325 (PUC-1962-62)
**MILLER, Paul D.,** Solubility of LiOH and $H_2O$, 17: 4520
**MILLER, R. R.,** Specific heat of materials, 17: 4523
**MILLS, R. L.,** Anomalous liquid-solid transformation of He-3, 17: 5133
**MILNES, M. V.,** Prog. rpt. on organic coolants, 4/1–5/30/62, 17: 5578 (IDO-11002)
**MILTON, J. C. D.,** Fission studies on U-233, U-235, and Pu-239, 17: 5334
**MINAMI, Shigeo,** Pomeranchuk particle and $\alpha$-meson reactions, 17: 5276
**MINAMI, Shigeo,** Regge trajectories and proton-antiproton interaction, 17: 5273
**MINSART, G.,** Operational parameters of BR2 reactor, 17: 5574 (BLG-119)
**MINTZER, David,** Wave propagation in partly ionized gas, 17: 5468
**MIRIMOVA, T. D.,** Radiation injuries associated with treatment of tumors, 17: 4400
**MISH, L. E.,** Plasma production by neutral-atom injection, 17: 5473
**MISHINA, Masanori,** Giant resonance in $Al^{27}(\gamma,n)$, 17: 5341
**MISHINA, Masanori,** Reactions $P^{31}(\gamma,n)$ and $S^{32}(\gamma,n)$, 17: 5342
**MISHLER, Larry,** Uranium powder ignition studies, 17: 4972
**MITANI, Kenji,** Negative radiation temperature at resonance in cold plasmas, 17: 5461
**MITCHELL, A. C.,** Gamma rays from interaction of 14-Mev neutrons with Li, 17: 5357
**MITRA, A. N.,** "Potential" for low energy $\alpha$-N interaction, 17: 5216
**MITTLEMAN, M. H.,** Coherent scattering of photons by atomic H, 17: 5137
**MITTRA, R.,** Maxwell's equations in magneto-ionic medium, 17: 5530 (AFCRL-62-247)
**MIURA, Masatoshi,** Graft polymerization by pre-irradiation, 17: 4607
**MIWA, H.,** X irradiation of the hypophysis. I., 17: 4406
**MIWA, H.,** X irradiation of the hypophysis. III., 17: 4407
**MJOLSNESS, R.,** Drift instabilities by collisional relaxation of high-energy particles, 17: 5499
**MJOLSNESS, R.,** Drift instabilities and particle relaxation, 17: 5514
**MODNIKOVA, V. V.,** Heat transfer during boiling in tubes, 17: 4663 (AEC-tr-5539)
**MOHANTY, Ganesh P.,** Unit cell and space group of $2Nb_2O_5-Ta_2O_5$, 17: 4505
**MOHR, W. C.,** Gas entrainment recoil target assembly, 17: 5422
**MOLINA, F.,** Geomagnetic, auroral, ionospheric and cosmic ray disturbance, 17: 5047 (AD-275256)
**MOLINARI, V. G.,** Neutron decay in a subcritical assembly, 17: 5305
**MOLSTAD, M. C.,** Solubilities of $LiBH_4$ and LiH in diethyl ether, 17: 4517
**MONARO, S.,** Levels in Co-57 from decay of Ni-57, 17: 5378
**MONESI, Valerio,** X-ray sensitivity and stages of cell cycle, 17: 4415
**MONKS, A. L.,** Modulus of elasticity of metallic alloys, 17: 4934 (AEC-tr-5534)
**MONTGOMERY, Donald Wheaton,** Shipping cask for radiation source, 17: 4756
**MOODIE, W. J.,** Prog. rpt. on organic coolants, 4/1–5/30/62, 17: 5578 (IDO-11002)
**MOODY, G. J.,** Radiation chemistry of carbohydrates. XI., 17: 4599
**MOORE, Graham Eric,** Extrusion or drawing of Be, 17: 4919
**MORAN, H. S.,** Collimator study for 5-Gev electron beam, 17: 5413 (ORNL-TM-423)
**MORAVCSIK, Michael J.,** Nucleon-nucleon elastic scattering, 17: 5055
**MORAVEK, Paul Haynal,** Antibaryon-nucleon annihilation, 17: 5289
**MORAWETZ, Cathleen S.,** Magnetohydrodynamic shock structure, 17: 5487
**MOREY, F.,** Construction of low-energy nuclear potentials, 17: 5380
**MORGAN, Russell H.,** Physical Foundations of Radiology, 3rd Ed., 17: 4431
**MORGENSHTERN, Z. L.,** Flash mechanism of SrS phosphors, 17: 5049 (UCRL-Trans-853(L))
**MORI, Akihiro,** Spatial confinement of plasma, 17: 5475
**MORI, T.,** Neoplasms in Negasaki survivors, 17: 4404
**MORIMOTO, Setsu,** NMR of Fe-57 in Li ferrite and magnetite, 17: 5113
**MORINAGA, H.,** Orbit flip magnetic transitions, 17: 5350
**MORIYA, Toru,** Nuclear magnetic relaxation near Curie temperature, 17: 5402
**MORPURGO, G.,** Reactions of hyperons and heavy mesons, 17: 5054
**MORRIS, D. F. C.,** Neutron-activation analysis, 17: 4470
**MORRIS, J. W.,** Dual-temperature manufacture of $D_2O$, 17: 4873
**MORRIS, James F.,** Damping of oscillations in nondegenerate plasma, 17: 5491
**MORRISON, David Lee,** Reactions (p,xp) in 100 to 400-Mev region, 17: 5323 (NYO-8921)
**MORROW, Frederick,** Production of Be of increased ductility, 17: 4988
**MOSCA, Domenico,** Supplies of enriched U for power plants, 17: 5610
**MOSCICKI, W. W.,** Construction of $CO_2$ proportional counters, 17: 4860
**MOSKACHEVA, K. A.,** Radiation injuries associated with treatment of tumors, 17: 4400
**MOSS, Charles,** Densification and granulation of $UO_2$, 17: 4987
**MOSSER, Donn G.,** Effects of x radiation on phospholipid metabolism. I., 17: 4419
**MOTOJIMA, K.,** Bibliography on analytical chemistry of reactor fuels and materials, 17: 4461 (JAERI-4023)
**MOTZ, L.,** Gauge invariance and structure of charged particles, 17: 5235
**MOURET, Pierre,** Alkaline treatment of U ores, 17: 4623
**MOUTON, W. L.,** Lifetimes of first excited states of $Li^7$ and $Na^{23}$, 17: 5386
**MOWER, Lyman,** Interaction between cold plasmas and guided EM waves. II., 17: 5500
**MUELLER, S.,** Measurement of radioactive substances in water, 17: 4815
**MULLEN, George Henry,** Quantization of Fermion theory, 17: 5290
**MUNRO, W.,** Deformation of Be under complex stressing, 17: 4970
**MUNSON, M. S. B.,** Reactions of rare gases with $N_2$ and CO, 17: 4527
**MURAKAMI, Keiichi,** Effects of $\gamma$ radiation on glass, 17: 5022
**MURPHY, C. A.,** Final rpt. on high-temperature ceramic structures, 11/1/61–10/31/62, 17: 4931 (NP-12306)
**MURRAY, R. B.,** Scintillation process in CsI(Tl), 17: 5034 (ORNL-3354)
**MURTHY, A. R. Vasudeva,** Differential thermal analysis of oxalates, 17: 4543
**MUSE, Lowell,** Activation analysis of Mn and Zn in sea water, 17: 4469
**MUSHA, Toshimitsu,** Negative absorption, 17: 5481
**MUSIL, F. J.,** Analysis for U in Al alloy, 17: 4459 (GAT-T-1053)
**MUSIL, F. J.,** Determination of lattice parameters, 17: 4490 (GAT-T-1052)
**MUSIL, Frank J.,** Lattice parameter of Si, 17: 4489 (GAT-T-1051)
**MUTSURO, Naoshi,** Giant resonance in $Al^{27}(\gamma,n)$, 17: 5341
**MUTSURO, Naoshi,** Reactions $P^{31}(\gamma,n)$ and $S^{32}(\gamma,n)$, 17: 5342

## N

**NADEAU, John S.,** Color centers and flow stress of LiF, 17: 5000
**NADI, M. El,** Analysis of (He-3,p) and ($\alpha$,n) reactions, 17: 5396
**NAHAVANDI, Amir N.,** Analysis of loss-of-coolant accident, 17: 5618
**NAIRN, J. S.,** Recovery of Pa-231 from U waste, 17: 4632
**NAKAGAWA, T.,** Irradiation effects on the hemogram of rabbits, 17: 4426
**NAKAGAWA, Takemi,** Giant resonance in $Al^{27}(\gamma,n)$, 17: 5341
**NAKAGAWA, Y.,** Interaction between plasma and dipole, 17: 5477
**NAKAMURA, A.,** Effect of placental plasma on x-ray dermatitis, 17: 4435
**NAKAMURA, Seitaro,** Theory of leptons, 17: 5272
**NAKHODKIN, N. G.,** Electron inelastic scattering in thin films, 17: 5281
**NAMIKI, Mikio,** Multiple production of particles, 17: 5399

**NAUMANN, R. J.,** Mirror-point distributions of trapped particles, 17: 5182
**NEAL, Richard A.,** Ionization behind shock waves in air. I., 17: 5131
**NEAL, S. B. H. C.,** Heat transfer along fuel cans, 17: 4667
**NEAMU, I.,** Neutron scattering on S-32 at 4.6 Mev, 17: 5327
**NEBOLSINA, L. I.,** Radiation injuries associated with treatment of tumors, 17: 4400
**NE'EMAN, Y.,** Inclusion of leptons in isospace, 17: 5266
**NEILSON, F. W.,** Explosively loaded metals yield behavior, 17: 4949
**NELSON, R. A.,** Final rpt. on interaction of EM waves with plasma, 4/62, 17: 5431 (AFCRL-62-185)
**NESMEYANOV, A. N.,** Vapor pressure of Y, 17: 4515
**NETA, P.,** Neutron reaction in fluoroorganic compounds, 17: 4603
**NETTLEY, P. T.,** Dimensional changes in graphite, 17: 5008
**NETZBAND, D.,** Light transfer in dE/dX counter, 17: 4833
**NEWSOME, John R.,** Radioprotective effects of Br · HBr (AET), 17: 4440
**NEY, E. P.,** Solid organic light sources, 17: 4789
**NGUYEN, Van-hieu,** Renormalization of $\beta$ decay axial constant, 17: 5201 (JINR-P-1051)
**NIEF, Guy,** Analysis of D in H-containing compounds, 17: 4488
**NIEMELA, L. Q.,** Decay of $K^+$, 17: 5202 (TID-14840)
**NIERENBERG, W. A.,** Atomic beams, 17: 5403
**NIEWOLD, A.,** Thermionic hollow cathodes, 17: 5083
**NIGHTINGALE, R. E.,** Radiation effects on carbons and graphites, 17: 4989 (HW-SA-2368)
**NIKITIN, Yu. P.,** Inverse of decay $\pi \to \mu + \nu$ in nucleus, 17: 5288
**NIKITINE, Serge,** Radiation effects on absorption spectrum of cuprite, 17: 4994
**NISHIWAKI, Yasushi,** Liquid scintillation counter, 17: 4824
**NOBLE, L. M.,** Hydrodynamic models of solar corona, 17: 5169
**NOGAMI, Yukihisa,** Interpretation of $\rho$ and $\zeta$ mesons, 17: 5248
**NORDLING, C. L.,** Properties of levels of Fm-254, 17: 5330
**NORWOOD, J., Jr.,** Measuring electrical conductivity, 17: 4786
**NOVIKOV, G. I.,** Evaporation in the KCl, $LnCl_3$ (La, Ce, Pr, Nd), 17: 5284
**NOVOZHILOV, Y. V.,** Theory of elementary particles symmetry, 17: 5283
**NOWIK, I.,** Hyperfine interactions of Dy-160 in garnet, 17: 5031 (AFOSR-2535)
**NOWOTNY, H.,** Pyrophorous alloys, 17: 4935 (AEC-tr-5545)
**NOYES, H. Pierre,** Nucleon-nucleon elastic scattering, 17: 5055
**NUNEZ-LAGOS, R.,** Complex plane of angular momentum, 17: 5548
**NUYTS, J.,** Conserved and partially conserved currents, 17: 5219
**NYBORG, P.,** Macroscopic motion of classical spinning particles, 17: 5240

## O

**OBERMAN, Carl,** High-frequency conductivity of fully ionized plasma, 17: 5497
**O'BRIEN, B. J.,** Electrons in outer radiation zone, 17: 5183
**O'DELL, T. H.,** Electrodynamics of magneto-electric media, 17: 5126
**ODERA, Masatoshi,** Photoprotons from Na, 17: 5343
**ODIAN, A.,** Photoproduction of muon pairs in C, 17: 5260
**ODIAN, George,** Radiation-induced graft polymerization, 17: 4583 (TID-7643(p.233-44))
**ODIAN, George,** Radiation crosslinking of polymers, 17: 4584 (TID-7643 (p.245-58))
**OFER, S.,** Hyperfine interactions of Dy-160 in garnet, 17: 5031 (AFOSR-2535)
**OFTE, Donald,** Density of molten Pu, 17: 4944
**OGASAWARA, Masatada,** Velocity distribution of ions in plasma, 17: 5457
**OGAWA, Shizuko,** NMR of Fe-57 in Li ferrite and magnetite, 17: 5113
**OHARA, S.,** Ramsauer effect in plasmas, 17: 5493
**OHSHIMA, C.,** Radiation-induced heterogeneous lethal factor, 17: 4434
**OJALVO, I. U.,** Conduction with time-dependent heat sources, 17: 4666
**OKAMURA, S.,** Radiation-induced polymerization of ketene, 17: 4572 (TID-7643(p.28-55))
**OKAMURA, S.,** Radiation-induced polymerization of cyclic monomers, 17: 4579 (TID-7643(p.150-77))
**OKAMURA, Seizo,** Radiation-induced polymerization by triple bonds, 17: 4609
**OKAMURA, Seizo,** Radiation-induced copolymerization, 17: 4613
**OKANO, Tetsuya,** Ternary system $PbO-TiO_2-ZrO_2$, 17: 4963
**OKONOGI, Hisaichiro,** Resonances in terms of compound states, 17: 5268
**OKUDA, Takeo,** Production of $UF_4$ from U raw material, 17: 4624
**OLANDER, Donald R.,** Extraction by TBP–n-hexane solvents. I., 17: 4634
**OLIVE, D. I.,** Unitarity and evaluation of discontinities, 17: 5543
**OLTEANU, I.,** Irradiation device attached to reactor, 17: 4991
**OMBRELLARO, P. A.,** Calculating fast few-group constants, 17: 5298 (KAPL-2220)
**ONNO, P.,** Line widths of scintillation counters, 17: 4841
**ONO, Kazuo,** Isomer shift of Fe-57, 17: 5111
**OREAR, J.,** Elastic p-p cross sections, 17: 5258
**O'REAR, J. G.,** Properties of Ce and Fe compounds, 17: 4450
**O'REILLY, Bruce D.,** Transformations between half-range and full-range angular expansions, 17: 5206 (WAPD-T-1305)
**O'REILLY, D. E.,** Analysis of NMR line shapes by lattice harmonics, 17: 5134
**OREN, Yona,** Cherenkov radiation from extensive air showers, 17: 5197
**ORR, Clyde, Jr.,** Final rpt. on thermal precipitator, 5/15/59–5/15/62, 17: 4641 (TID-17378)
**ORR, D.,** Particle motions in spiral ridge magnetic fields, 17: 5424
**ORTNER, J.,** Cosmic noise absorption, 17: 5092
**OSBORNE, F. J. Fitz,** Microwave system for plasma studies, 17: 5448
**OSHIMA, Yotaro,** Liquid scintillation counter, 17: 4824
**OSHIYAMA, Hiroshi,** Spatial confinement of plasma, 17: 5475
**OSTROUKHOV, A. A.,** Electron inelastic scattering in thin films, 17: 5281
**OTSUKI, Shoichiro,** Resonances in terms of compound states, 17: 5268
**OVENFORS, C. O.,** Renal angiography with $ThO_2$, 17: 4382
**OVERHOLSER, L. G.,** Degassing behavior of commercial graphites, 17: 4986
**OVERMAN, R. F.,** Coincidence counting of special samples, 17: 4845
**OVERMAN, R. R.,** Radioprotective effects of Br · HBr (AET), 17: 4440
**OWCZARSKI, W. A.,** Getting the most from projection welding, 17: 4915
**OZAKI, S.,** Decay of $K^+$, 17: 5202 (TID-14840)
**OZEROFF, W. J.,** Diffusion of electrons in scattering medium, 17: 5241

## P

**PALFREY, T. R.,** Polarization of high-energy photoprotons from light elements, 17: 5389
**PALMER, Howard B.,** Mechanisms of C deposition, 17: 4514
**PALMER, P. E.,** Thorium–V phase diagram, 17: 4936
**PALUMBO, C. J.,** Propagation of amplitude-modulated EM wave in plasma, 17: 5509
**PALUMBO, Carl J.,** Nonlinear propagation of EM waves in plasma, 17: 5506
**PALUMBO, D.,** Plasma physics and magnetohydrodynamics, 17: 5520
**PAN, C. H. T.,** Two-dimensional incompressible MHD flows, 17: 5483
**PAN, Kuan,** Oxidation potential of cerous–ceric electrode, 17: 4539
**PAN, Kuan,** Photochemical reduction of uranyl sulfate, 17: 4606
**PAN, V. M.,** Phase diagram of $Cr-Ni-Ni_3Nb-NbCr_2$ system, 17: 4978
**PANDE, A.,** Methods of moisture measurement, 17: 4465
**PANDE, C. S.,** Methods of moisture measurement, 17: 4465
**PANDYA, S. P.,** Effective nuclear interactions in finite nuclei, 17: 5366
**PANISH, M. B.,** Vaporization and physical properties of refractories, 17: 4933 (WADD-TR-60-463(Pt.II))
**PANKEY, Titus, Jr.,** Thermonuclear activities in minerals, 17: 4716
**PARFENOVA, E. G.,** Protective reactions in radiation sickness, 17: 4439
**PARHAM, A. G.,** Charged $\pi$ meson production in p-p collisions, 17: 5199 (AERE-R-3969)
**PARIISKII, G. B.,** Hydrogen atoms formed in silica gel by irradiation, 17: 4615
**PARK, Kilho,** Pure aragonite synthesis, 17: 4540
**PARK, R. B.,** Prog. rpt. on bio-organic chemistry, 6–8/62, 17: 4380 (UCRL-10479)
**PARKS, D. E.,** Neutron decay in a subcritical assembly, 17: 5305
**PARLY, Bernard,** Alkaline treatment of U ores, 17: 4623
**PASKIN, Arthur,** Image of Fermi surface in lead, 17: 5146
**PATOCKA, J.,** Interactions of fast pions with nuclei, 17: 5214
**PATROVSKY, V.,** Determination of Nb, Ta, and Ti, 17: 4464
**PATTERSON, J. D.,** Density matrix representations, 17: 5051
**PAUL, Harry,** Theory of $\gamma$-$\gamma$ angular correlation. I., 17: 5328
**PAUL ,Harry,** Theory of $\gamma$-$\gamma$ angular correlation. II., 17: 5329
**PAVESI, B.,** Meteorological information for reactor startup, 17: 4694
**PAVLIK, Albert, Jr.,** Purification of $Sr(NO_3)_2$, 17: 4558
**PAYNE, Anthony Luke,** Geology of Colorado Plateau, 17: 4714

**PEEK, H. Milton,** Spark-discharge light source for time-resolved absorption spectroscopy, 17: 4773 (TID-14796)
**PEHL, Richard H.,** Semiconductor transmission-counter system, 17: 4852
**PELAH, I.,** Fuel temperature increase following "loss of coolant" accident, 17: 5583
**PENDLETON, Joseph Raymond,** Improvements in position-indicating apparatus, 17: 5592
**PENNINGTON, Edgar T.,** Ionization vacuum gage, 17: 4802
**PENNISI, G.,** Bromine-82 labeling of human serum albumin, 17: 4387
**PENSO, G.,** Neutrinoless coherent nuclear capture of $\mu^-$ mesons, 17: 5377
**PEPIN, T. J.,** Solid organic light sources, 17: 4789
**PERES, A.,** Cauchy's problem in general relativity. II., 17: 5542
**PERES, A.,** Cauchy's problem in general relativity. III., 17: 5549
**PERICART, J.,** MHD generation of electrical energy, 17: 5527
**PERLMUTTER, M.,** Thermal radiation in a heated tube, 17: 4671
**PERRIER, M.,** Dioxane addition compounds, 17: 4452
**PERRYMAN, E. C. W.,** Problems in water reactors, 17: 4907
**PERSANO, A.,** Meteorological information for reactor startup, 17: 4694
**PETERKOP, R.,** Multichannel effective range theory and electron–H scattering, 17: 5150
**PETERS, F. G.,** Controlled multicomponent sputtering, 17: 4892
**PETERS, M. C.,** Pressure vessel reactor designs, 17: 5611
**PETERSON, G. A.,** Nuclear excitation by 180° electron scattering, 17: 5388
**PETERSON, J. R.,** Cross sections for electrons in $N_2$, 17: 5142
**PETERSON, R. H.,** Neutron flux from point source in air, 17: 5294 (BRL-Memo-1432)
**PETRAVIC, M.,** Reaction $V^{51}(n,d)Ti^{50}$ at 14.4 Mev, 17: 5385
**PETROV, V. A.,** Dosimetric characteristics of electron sources, 17: 4749
**PETSCHEK, H. E.,** Magnetic annular shock-tube operation, 17: 5466
**PEYRET, R.,** Fluid magnetodynamics and gas dynamics, 17: 4678
**PEYSER, Leonard F.,** X-ray cone, 17: 4800
**PHILLIPS, G. C.,** Phase-shift analysis of scattering of protons from O, 17: 5355
**PHILLIPS, G. M.,** Recovery of Pa-231 from U waste, 17: 4632
**PHILLIPS, G. O.,** Radiation chemistry of carbohydrates. XI., 17: 4599
**PHILLIPS, Gwilym Morgan,** Methods of recovering Pu, 17: 4636
**PHILLIPS, R. J. N.,** Regge pole model for p-p and $\bar{p}$-p scattering, 17: 5255
**PHILLIPS, R. J. N.,** Triangle inequalities for spin effects, 17: 5544
**PIAZZA, J. R.,** Phase equilibria in C–O–U, 17: 4518
**PICARD, F.,** Lithium-6$(d,\alpha)\alpha$ reaction, 17: 5322 (NP-12258)
**PICKUP, E.,** One-pion exchange in $\pi^-$-p interactions, 17: 5251
**PIERAGOSTINI, F.,** Neutron irradiation effects of Al dislocation damping, 17: 5013
**PIERANTONI, F.,** SOPHY—reactor design codes, 17: 4877 (CNEN-141)
**PIERCE, W. G.,** Rock salt deposits in the US, 17: 4705
**PIERCE, W. L.,** Nuclear magnetic dipole moment of Ca-41, 17: 5390
**PIERMARINI, G. J.,** High-pressure transition in RbF, 17: 4536
**PIGORINI, Francesco,** Beta-isotope contact therapy: techniques and dosimetry, 17: 4383
**PINDER, H. G.,** Minimizing downtime of power reactors, 17: 5609
**PINSON, W. H., Jr.,** Geochronology by Sr isotope variations, 17: 4706
**PIRRWITZ, D.,** Production of short-lived radionuclides, 17: 4759
**PITTS, J. J.,** Intercalation of Co(II) chloride in graphite, 17: 4552
**PLAMONDON, J. A.,** Thermal efficiency of coated fins, 17: 4670
**PLILER, R.,** Distribution of Th in Mancos shale, 17: 4696
**PLILER, R.,** Distribution of Th in weathering profile, 17: 4697
**PLUGGE, Richard J.,** EM parameters for hypersonic plasma sheath, 17: 5430 (AD-276418)
**PODGOR, S.,** J-values of s-type neutron resonances. II., 17: 5300 (NRL-5851)
**POHLIT, Wolfgang,** Extrapolation chamber for measuring photon and electron radiation, 17: 4858
**POIRIER, John A.,** Total-absorption scintillation counter, 17: 4854
**POKORNY, Ernst Adalbert,** Manufacture of Nb by fusion electrolysis, 17: 4901
**POLI, P.,** SOPHY—reactor design codes, 17: 4877 (CNEN-141)
**POLKINGHORNE, J. C.,** Anomalous thresholds in unitary theories, 17: 5562
**POMERANCHUK, I. Ya.,** Elastic scattering amplitude at high energies, 17: 5217
**POMERANCHUK, I. Ya.,** Regge poles and Landau singularities, 17: 5264
**POMERANTZ, M. A.,** Spatial distribution of cosmic ray intensity, 17: 5192
**POPOVA, A. M.,** Decay of C-12 caused by $\alpha$ particles, 17: 5361
**PORTER, Terence L.,** Spectrum of Hg hydride, 17: 5109
**POTTIER, Jacques,** Structure for linear ion accelerators, 17: 5428
**POTTIER, Paul,** Alkaline treatment of U ores, 17: 4623
**POULOS, N. E.,** Final rpt. on high-temperature ceramic structures, 11/1/61–10/31/62, 17: 4931 (NP-12306)
**POWELL, D. B.,** Radiation sterilization of surgical materials, 17: 4761
**PRAGER, Stephen,** Viscous flow through porous media. II., 17: 4679
**PRICE, P. B.,** Etching of charged particle tracks in solids, 17: 4999
**PRICE, P. B.,** Observations of charged particle tracks in solids, 17: 4998
**PRIESTER, Wolfgang,** Models for solar-cycle variation, 17: 5170
**PRIMAK, W.,** Radiation-induced dilatations in vitreous silica, 17: 5016
**PRISELKOV, Yu. A.,** Vapor pressure of Y, 17: 4515
**PROPST, Robert C.,** Polarographic test for solvent quality. II., 17: 4456 (DP-772)
**PROSPERI, G. M.,** Analytic continuation of S-matrix in angular momentum, 17: 5552
**PROTOPAPADAKIS, P. A.,** Hyperon-nucleon scattering, 17: 5220
**PRZEDMOJSKI, Jan,** High-pressure x-ray chambers, 17: 4848
**PSZONA, Stanislaw,** Producing standard radioactive sources for calibrating dosimeters, 17: 5009
**PUGLISE, M.,** Frascati electron synchrotron, 17: 5416
**PURCHAS, John Guy,** Brazed seal between two members, 17: 4921
**PUZA, A.,** Autoinfection after total-body lethal irradiation, 17: 4433
**PUZOVA, Hana,** Autoinfection after total-body lethal irradiation, 17: 4433
**PYKE, Thomas Mealor,** Improvements in electrolytic cells, 17: 4655
**PYKE, Thomas Mealor,** Improvements in electrolytic cells, 17: 4656

## Q

**QUASTLER, Henry,** Radiation effects on intestinal epithelium. I., 17: 4420
**QUENBY, J. J.,** Cosmic ray threshold rigidities, 17: 5190
**QUENBY, J. J.,** Particle flux produced by high-altitude explosion, 7/9/62, 17: 5115
**QUIMBY, Edith H.,** Physical Foundations of Radiology, 3rd Ed., 17: 4431
**QUINN, John J.,** Properties of quantum plasma in magnetic field, 17: 5507

## R

**RABANI, Joseph,** Electrons in irradiated aqueous solutions, 17: 4602
**RABINOWITZ, M.,** Electrical breakdown in vacuum, 17: 4640 (TID-15465)
**RADLOW, James,** Transverse MHD flow past semi-infinite plate, 17: 5485
**RADVANYI, Pierre,** Semiconductor junction barrier detectors, 17: 4849
**RAETHER, M.,** Collision cross section of slow electrons and ions with Cs, 17: 5136
**RAFALOVSKII, V. A.,** Formation of $\omega$ phase in Hf alloys, 17: 4979
**RAJALA, B. R.,** Prog. rpt. on V alloys, 9/18–11/17/62, 17: 4924 (ARF-B231-7)
**RAJEWSKY, B.,** Secondary reactions in x-irradiated protein, 17: 4429
**RAJNAK, Katheryn Edmonds,** Configuration interaction in rare earths, 17: 4498 (UCRL-10460)
**RAKESTRAW, N. W.,** Radiocarbon dating of deep water, 17: 4713
**RAMAKOTESWARA RAO, P.,** Band spectrum of CuCl molecule. IV., 17: 5070
**RAMASWAMY, M. K.,** First excited state in Mg-26, 17: 5376
**RAND, R. E.,** Analysis of continuous spectra using matrix method, 17: 4831
**RAND, S.,** Absorption of radiation by the ionosphere, 17: 5469
**RANDALL, Charles H.,** Microscopic self-shielding, 17: 5301 (TID-13710)
**RANDALL, M. J.,** Horizontally polarized shear waves, 17: 5107
**RANDI, P.,** Diurnal oscillations of cosmic rays, 17: 5188
**RAPKIN, E.,** Measurement with liquid scintillators, 17: 4818
**RAPPERPORT, E. J.,** Al–Li phase diagram, 17: 4930 (NMI-7010)
**RARITA, W.,** Regge pole model for p-p and $\bar{p}$-p scattering, 17: 5255
**RASCHE, G.,** Removal of ghost state in Lee model, 17: 5556
**RASE, Siegfried,** Extrapolation chamber for measuring photon and electron radiation, 17: 4858
**RASHID, M. A.,** Product of three 8-dimensional representations, 17: 5545
**RASMUSSEN, Norman C.,** Neutron dosimetry, spectrometry, and activation

analysis, 17: 4807 (MITNE-8)
**RATTAY, K. H.**, Treatment of radioactive waste water, 17: 5652
**RAUSCH, Ludwig**, Radiobiological ionization sieve and screen irradiation. III., 17: 4424
**RAWSON, P. J.**, Hinkley Point fuel handling, 17: 5620
**READ, A. L.**, Elastic p-p cross sections, 17: 5258
**REDHARDT, A.**, Secondary reactions in x-irradiated protein, 17: 4429
**REDMAN, J. K.**, Reactor damage in pure, 17: 5001
**REDMOND, R. F.**, Energy spectrum of fission fragments from UO$_2$, 17: 5085
**REEH, H.**, Reduction of field operator algebra, 17: 5218
**REES, David George**, Improvements in reactor fuel elements, 17: 5589
**REICHERT, S. O.**, Radionuclides in groundwater, 17: 4700
**REIF, L.**, Vaporization and physical properties of refractories, 17: 4933 (WADD-TR-60-463(Pt.II))
**REIN, James E.**, Uranium, 17: 4485
**REMIZOV, O. V.**, Critical heat loads in forced flow of water, 17: 4662 (AEC-tr-5538)
**RETHMEIER, J.**, Scattering of 14.8-Mev neutrons from C and Bi, 17: 5359
**REYNOLDS, W. N.**, Stored energy in graphite of power reactors, 17: 5014
**RIBRAG, M.**, Determination of thermal neutron absorption, 17: 5319
**RICABARRA, Delfina**, Measurement of the U-238 Cd ratio, 17: 5373
**RICABARRA, Guillermo H.**, Measurement of the U-238 Cd ratio, 17: 5373
**RICCI, R. A.**, Levels in Co-57 from decay of Ni-57, 17: 5378
**RICH, E. I.**, Rock salt deposits in the US, 17: 4705
**RICHTER, Burton**, Photoproduction of pion pairs, 17: 5257
**RIDER, B. F.**, Prog. rpt. on nuclear fuel burnup analyses, 6–9/62, 17: 4460 (GEAP-4082)
**RIEKE, James K.**, Graft copolymers of polyethylene and acrylic acid, 17: 4591 (TID-7643(p.398-413))
**RIEMERSMA, H.**, High-field superconducting solenoid, 17: 4781
**RIESCH, G.**, Checkout of the AEG test reactor, 17: 5634
**RISTINEN, R. A.**, Double-focusing $\beta$ spectrometer and performance, 17: 4844
**RITSON, D. M.**, Decay of K$^+$, 17: 5202 (TID-14840)
**ROBBEN, Frank**, Ionization in MHD generator, 17: 5479
**ROBERTS, Louis D.**, Nuclear orientation, 17: 5056
**ROBERTSHAW, F. C.**, Effect of neutron irradiation on Inconel X, 17: 4992
**ROBERTSON, J. A. L.**, Consequences of excess O in UO$_2$, 17: 4894
**ROBERTSON, J. S.**, Dose-rate dependence of early radiation effects, 17: 4421
**ROBINSON, D. K.**, One-pion exchange in $\pi^-$-p interactions, 17: 5251
**ROBINSON, J. E.**, Screening correction to Slater exchange potential, 17: 5147
**ROBINSON, L. B.**, Phase transformation of ZrO$_2$, 17: 4519
**ROBINSON, Mark T.**, Sputtering with 1- to 5-kev Ar$^+$ ions, 17: 5089
**ROBSON, D.**, Origin of heavy particle stripping, 17: 5397
**ROCHE, Roland**, Improvements in reactor cooling systems, 17: 5599
**RODENBURG, M.**, Scattering of 14.8-Mev neutrons from C and Bi, 17: 5359
**RODRIGEUZ, S.**, Absorption of phonons by electron gas, 17: 5118
**RODRIGUEZ, Manuel Lopez**, Micrographic study of metal deposits on incandescent filaments, 17: 4890
**RODRIGUEZ, Sergio**, Properties of quantum plasma in magnetic field, 17: 5507
**ROEPKE, H.**, Producing neutral atomic H beam, 17: 5117
**ROESLER, Frederick Lewis**, Behavior of He II line in hollow cathode discharge, 17: 5161
**ROGERS, L. B.**, Thermal analysis of decomposition of Na carbonates, 17: 4495 (TID-13772)
**ROHR, W. G.**, Density of molten Pu, 17: 4944
**ROHRLICH, F.**, Conformal invariance in physics, 17: 5572
**ROMANOVA, A. V.**, X-ray studies of liquid In alloys with Pb and Sn, 17: 4977
**ROMANOVSKII, V. A.**, Electron inelastic scattering in thin films, 17: 5281
**RON, Amiram**, High-frequency conductivity of fully ionized plasma, 17: 5497
**RONA, Elizabeth**, Activation analysis of Mn and Zn in sea water, 17: 4469
**RONCHETTO, Joseph J., Jr.**, Tape transport, 17: 4644
**ROOF, R. B., Jr.**, Empirical approach to anomalous dispersion, 17: 5045 (TID-14794)
**ROSA, U.**, Bromine-82 labeling of human serum albumin, 17: 4387
**ROSE, D. C.**, Intensity level of cosmic rays in Canada, 17: 5180
**ROSE, D. J.**, Distributions in one-dimensional plasma sheaths, 17: 5452
**ROSE, P. H.**, High-voltage acceleration tubes, 17: 5420
**ROSE, Peter H.**, Reduction in tandem loading, 17: 5427
**ROSEN, C. L.**, Vaporization and physical properties of refractories, 17: 4933 (WADD-TR-60-463(Pt.II))
**ROSEN, S. P.**, Nonleptonic hyperon decay theory, 17: 5256
**ROSENBLUTH, Marshall N.**, Anomalous diffusion from microinstabilities in plasma, 17: 5496
**ROSENBLUTH, Marshall N.**, Trapping instabilities in inhomogenous plasma, 17: 5486
**ROSESCU, Th.**, Experimental scope of VVR-S reactor, 17: 5633
**ROSINI, E.**, Meteorological information for reactor startup, 17: 4694
**ROSNER, Daniel E.**, Magnetogasdynamic thrust vectoring of rocket motors, 17: 5641 (NP-12264)
**ROSSBERG, L.**, Effect of DNA macrostructure on extinction modifications, 17: 4618
**ROSSER, W. G. V.**, Electrons in outer radiation zone, 17: 5183
**ROSSI, G.**, Coolant temperature coefficient and group diffusion model, 17: 5306
**ROST, E.**, Inelastic scattering of $\alpha$ particles. I., 17: 5382
**ROST, E.**, Inelastic scattering of $\alpha$ particles. II., 17: 5383
**ROTBLAT, J.**, Scattering of He-3 particles by N-14 and O-16, 17: 5363
**ROTH, C.**, Triton core in hypernucleus H$^4$, 17: 5332
**ROTHENSTEIN, W.**, Dancoff correction in gap geometry, 17: 5309
**ROUGH, F. A.**, Fission-gas release from UO$_2$, 17: 4896
**ROUGH, F. A.**, Irradiation damage in UC, 17: 4900
**ROUND, V.**, Fast closing vacuum valve, 17: 4650
**RUBBIA, C.**, Neutrinoless coherent nuclear capture of $\mu^-$ mesons, 17: 5377
**RUBBINO, A.**, Reactions O$^{16}$(d,p) and (d,$\alpha$) at 0.8 to 2.0 Mev, 17: 5367
**RUBIN, A. B.**, Betatron potential wells, 17: 5421
**RUBY, S. L.**, Magnetic properties of FeTiO$_3$–$\alpha$Fe$_2$O$_3$, 17: 4959
**RUDNICK, I.**, Fourth sound in He II, 17: 5143
**RUDOLPH, P. S.**, Effects of $\alpha$ radiation on *R. spheroides*, 17: 4416
**RUEL, Marion**, Capture of muons by C-12, 17: 5409
**RUSCH, G. K.**, A-C ionization chamber, 17: 4805 (DC-60-2-80)
**RUSSELL, F. M.**, Particle detectors. I., 17: 4820
**RUSSELL, J. A.**, Range of electron densities in transient plasmas, 17: 5432 (AWRE-O-14/62)
**RUSSELL, Lewis Eric**, Production of sintered UO$_2$, 17: 4922
**RUTHERFORD, Henry A.**, Textile fiber modification radiation-induced graft polymerization. I., 17: 4586 (TID-7643(p.268-99))
**RYER, C. M.**, Powder fuel processing, 17: 4909 (GEAP-3891)

## S

**SAARIVIRTA, Matti J.**, High conductivity Cu–Zr–As alloys, 17: 4938
**SABAU, M.**, Experimental scope of VVR-S reactor, 17: 5633
**SABELS, B. E.**, Age studies on basaltic lava flows, 17: 4712
**SACERDOTI, G.**, Frascati electron synchrotron, 17: 5416
**SACHARIDIS, E. J.**, Charged $\pi$ meson production in p-p collisions, 17: 5199 (AERE-R-3969)
**SADEGHI, A.**, Lithium-6(d,$\alpha$)$\alpha$ reaction, 17: 5322 (NP-12258)
**SAENZ, A. W.**, l-values of s-type neutron resonances. II., 17: 5300 (NRL-5851)
Saenz de Tejada Gonzalez, Luis M.
*see de Tejada Gonzalez, Luis M. Saenz*
**SAEUFFERER, H.**, Damages to fuel cans in water cooled reactors, 17: 5007
**SAGAN, Carl**, Martian blue haze and solar protons, 17: 5168
**SAGAWA, M.**, Effects of P-32 on hematopoietic system. I., 17: 4427
**SAGAWA, M.**, Effect of P-32 on hematopoietic system. II., 17: 4428
**SANCHO, J.**, Reversible and irreversible processes in dropping Hg electrode. XIII., 17: 4507
**SAITO, N.**, Bibliography on analytical chemistry of reactor fuels and materials, 17: 4461 (JAERI-4023)
**SAKAI, Hajime**, Absorption lines in H$_2$O pure rotation spectrum, 17: 4771 (NP-12236)
**SAKAMOTO, Y.**, Quasi-elastic scattering of proton by p-protons of Li-6, 17: 5379
**SAKUMA, Tetsuro**, Electromagnetic form factors of nucleon, 17: 5274
**SAKURAI, Akira**, Interaction of shock wave with magnetic field, 17: 5459

**SAKURAI, J. J.,** On the tenfold way, 17: 5233
**SAKURAI, J. J.,** Vector mesons and KN, $\bar{K}$N interactions, 17: 5246
**SAKURAI, Takeo,** Gravity waves of conducting fluid, 17: 5476
**SAKURAI, Tosio,** Applications of nuclear quadrupole resonance, 17: 4443 (AFOSR-2542)
**SALANT, E. O.,** One-pion exchange in $\pi^-$-p interactions, 17: 5251
**SALMON, Robert J.,** Effects of x radiation on phospholipid metabolism. I., 17: 4419
**SAMS, John R., Jr.,** Interaction of Xe with graphitic C, 17: 4534
**SANATANI, S.,** Effect of Bragg cutoff on thermal neutron diffusion, 17: 5316
**SANDENAW, Thomas A.,** Physical properties of Pu, 17: 4983
**SANFORD, J. R.,** Properties of the $\eta$ meson, 17: 5259
**SANDSTROEM, Arne Eld,** Direction of the cosmic ray anisotropy, 17: 5196
**SANTOMAURO, L.,** Meteorological information for reactor startup, 17: 4694
**SARAPH, H. E.,** Iteration-variation method for atomic scattering, 17: 5565
**SARTAIN, C. C.,** Radiation damage and ferroelectric effect in Rochelle salt, 17: 5003
**SARTORI, L.,** Magnetic moment of Lee particle, 17: 5249
**SASTRY, Bhamidipaty Venkata Rama,** Pharmacological behavior of Cs-137, 17: 4391
**SATCHLER, G. R.,** Inelastic scattering of $\alpha$ particles. I., 17: 5382
**SATCHLER, G. R.,** Reaction $V^{51}$(n,d)$Ti^{50}$ at 14.4 Mev, 17: 5385
**SATO, Shigeo,** Theory of leptons, 17: 5272
**SATO, Y.,** Aromatic H exchange in methoxybenzenes, 17: 4560 (TID-17369)
**SAUER, Kenneth,** Prog. rpt. on bio-organic chemistry, 6–8/62, 17: 4380 (UCRL-10479)
**SAULIT, V. R.,** Focusing of charged particles, 17: 5157
**SAUNDERS, Charles E., Jr.,** Remote-control manipulator, 17: 4659
**SAWADA, Shoji,** Lepton energy spectra in $K^+_{e3}$-decay, 17: 5275
**SAWAGUCHI, Etsuro,** Dielectric constant of Sr titanate, 17: 4960
**SAWHNEY, Dulari L.,** Vapor pressure of alkali metals, 17: 4947
**SAWYER, G. A.,** Gas purity in plasma physics, 17: 5515
**SAXENA, M. C.,** Complex formation by Ce(III), 17: 4544
**SAXTON, Harry J.,** Atomic mobility in liquid metals, 17: 4945
**SCANLON, J. P.,** Efficiencies for detecting neutrons in organic scintillators, 17: 4836
**SCARBOROUGH, J. M.,** Yield of H from biphenyl, 17: 4605
**SCARF, F. L.,** Hydrodynamic models of solar corona, 17: 5169
**SCARF, F. L.,** Solution for Thirring model, 17: 5546
**SCARPA, Giorgio,** Beta-isotope contact therapy, techniques and dosimetry, 17: 4383
**SCASSELLATI, G. A.,** Bromine-82 labeling of human serum albumin, 17: 4387
**SCHAEFFER, O. A.,** Measurement of Al-26 and Be-10 in meteorites, 17: 4717
**SCHAEFFER, Oliver A.,** Radiochemistry of meteorites, 17: 4693
**SCHANZE, U. O.,** Activity in radioactive waste waters, 17: 5651
**SCHARZ, Joachim,** Bladder tumors after radiation therapy, 17: 4385
**SCHEELE, George F.,** Stability of flow in a vertical pipe, 17: 4669
**SCHERBATSKOY, Serge A.,** Pipe-line exploration, 17: 4768
**SCHETZ, J. A.,** Unsteady natural convection in vertical plate, 17: 4672
**SCHLEGEL, H.,** Liquid scintillation counter for C-14 compounds, 17: 4821
**SCHLIEDER, S.,** Reduction of field operator algebra, 17: 5218
**SCHLUETER, H.,** Metastable He atom concentrations, 17: 5149
**SCHLUMBOHM, H.,** Development of canal discharges in gases, 17: 5158
**SCHNEIDER, Christel,** Radiation-induced polymerization of vinyl monomers, 17: 4596
**SCHNIZLEIN, Glenn,** Uranium powder ignition studies, 17: 4972
**SCHOLZ, S.,** Enrichment of C-13, 17: 4871 (AEC-tr-5526)
**SCHONFELD, F. W.,** Plutonium phase diagrams, 17: 4984
**SCHOPPER, E.,** Nuclear resonance fluorescence and Mössbauer effect, 17: 5404
**SCHRADER, C. D.,** Gamma rays from interaction of 14-Mev neutrons with Li, 17: 5357
**SCHRIEFFER, J. R.,** Screening correction to Slater exchange potential, 17: 5147
**SCHROECK-VIETOR, W.,** Measurement of low activities, 17: 4813
**SCHROEDER, Ellinor,** Antioxidants and survival rate of irradiated mice, 17: 4442
**SCHULL, William J.,** Analysis of multi-factor tables, 17: 4381
**SCHULTZ, Harvey,** Color centers in KCl, 17: 5025
**SCHUMACHER, B. W.,** Gas density gauging, 17: 4777
**SCHUMAR, J. F.,** High-temperature materials for nuclear applications. I., 17: 4969
**SCHWARTZ, Daniel,** Neutron dosimetry, spectrometry, and activation analysis, 17: 4807 (MITNE-8)
**SCHWARZ, Helmut,** Optimally focused space-charge-limited electron beams, 17: 5086
**SCHWENDIMAN, L. C.,** Air oxidation of U, 17: 4491 (HW-SA-2641)
**SCHWERTFUEHRER, W.,** Measuring energy spectrum of cyclotron ion beam, 17: 5419
**SCIBONA, G.,** Amine extraction of $HNO_3$, 17: 4453
**SCOTTEN, W. C.,** Dual-temperature manufacture of $D_2O$, 17: 4873
**SCOTT-MONCK, J.,** Radiation defect introduction rates in n- and p-type Si, 17: 5015
**SEATON, M. J.,** Iteration-variation method for atomic scattering, 17: 5565
**SECRETAN, L. [illegible].,** Flat and curved monochromator crystals in neutron spectrometers for investigating single crystals, 17: 4775 (NP-tr-923)
**SEGEL, S. L.,** Resonance of Cl-35 in $FeCl_3$, 17: 4537
**SEGRE, Emilio,** Annual Review of Nuclear Science, Vol. 11, 17: 5053
**SELECKI, Anatol,** Natural isotopes. IV., Separation by electrolysis, 17: 4874
**SELLERI, Franco,** Nucleon-nucleon diffraction scattering, 17: 5243
**SELLSCHOP, J. P. F.,** Lifetimes of first excited states of $Li^7$ and $Na^{23}$, 17: 5386
**SELTZER, Stanley,** $\alpha$-Deuterium isotope effect and Diels-Alder reaction, 17: 4568
**SEN GUPTA, H. M.,** Scattering of He-3 particles by N-14 and O-16, 17: 5363
**SENNIS, C.,** Meteorological information for reactor startup, 17: 4694
**SESMA, J.,** Observables of relativistic particles, 17: 5208
**SHABALIN, E. P.,** Inverse of decay $\pi \to \mu + \nu$ in nucleus, 17: 5288
**SHAEVICH, A. B.,** Instrumentation terms clarification, 17: 4780
**SHAH, S. K.,** Effective nuclear interactions in finite nuclei, 17: 5366
**SHAPIRO, F. L.,** Increase of intensity in time-of-flight measurements, 17: 4810 (AEC-tr-5540)
**SHAPIRO, I. S.,** Amplitude vertex parts of direct nuclear processes, 17: 5360
**SHAPIRO, K. A.,** Fourth sound in He II, 17: 5143
**SHARP, David H.,** M meson and generalization of Pomeranchuk relations, 17: 5250
**SHARP, E. L.,** Smear techniques for surface monitoring for radioactive materials, 17: 4743 (ORNL-TM-435)
**SHARP, R. T.,** Triton core in hypernucleus $H^4$, 17: 5332
**SHAW, David,** Converting solution of radioactive salt into solid, 17: 4620
**SHCHUKAREV, S. A.,** Enthalpy of Nb oxytrichloride, 17: 4550
**SHEA, M. A.,** Asymptotic directions of primary cosmic protons, 17: 5179 (AFCRL-62-453)
**SHEARER, Samuel David, Jr.,** Leachability of Ra-226, 17: 5653
**SHEEN, E. M.,** Alpha monitor with solid state detector, 17: 4840
**SHEFFIELD, J.,** Switch for high-energy capacitors, 17: 4782
**SHEFFIELD, J. C.,** Reversed-biased p-n junctions, 17: 4787
**SHEMYAKINA, T. S.,** Enthalpy of Nb oxytrichloride, 17: 4550
**SHEPHEARD, Robert G.,** Behavior of stainless steel in He, 17: 4980
**SHERA, E. Brooks,** Angular correlation measurements with multichannel analyzers, 17: 4843
**SHERBY, Oleg D.,** Atomic mobility in liquid metals, 17: 4945
**SHERIF, H.,** Analysis of (He-3,p) and ($\alpha$,n) reactions, 17: 5396
**SHESTOPALOVA, S. A.,** Two-fold focusing $\beta$ spectrometer, 17: 4834
**SHEWCHUCK, Sergey,** Expansion of a circular cylindrical tube subjected to dynamic loads, 17: 4642 (UCRL-Trans-876(L))
**SHEWCHUCK, Sergey,** Flash mechanism of SrS phosphors, 17: 5049 (UCRL-Trans-853(L))
**SHEWCHUCK, Sergey,** Recombination of phosphorescence, 17: 5048 (UCRL-Trans-852(L))
**SHIBANO, Hiroshi,** Radiation-induced polymerization of copolymers, 17: 4611
**SHIDA, S.,** ESR of electron-irradiated cycloheptatriene, 17: 4604
**SHIMA, M.,** Boron in meteorites, 17: 5097
**SHIMIZU, Koichi,** Photoprotons from Al, 17: 5340
**SHIRANE, G.,** Magnetic properties of $FeTiO_3$–$\alpha Fe_2O_3$, 17: 4959
**SHODA, Katsufusa,** Photoprotons from Al, 17: 5340
**SHORE, Bruce W.,** Usefulness of solar outburst prediction, 17: 5164

**SHPARO, L. A.**, Radiation injuries associated with treatment of tumors, 17: 4400
**SHUNK, Francis**, Liquid Zr–rare earth alloys, 17: 4943
**SIEGBAHN, K.**, Properties of levels of Fm-254, 17: 5330
**SIEGEL, R.**, Thermal radiation in a heated tube, 17: 4671
**SIGNARBIEUX, C.**, Determination of thermal neutron absorption, 17: 5319
**SILBERG, Paul A.**, Ball lightning and plasmoids, 17: 5455
**SILL, Claude W.**, Beryllium content of meteorites, 17: 4698
**SILLARS, R.**, Steady-state electron densities for irradiated plasmas, 17: 5437 (GCA-TR-62-8-A)
**SILTANEN, J. N.**, Irradiation of Pu–UO$_2$ fuel, 17: 4898
**SIMMONS, J. H. W.**, Stored energy in graphite of power reactors, 17: 5014
**SIMMONS, W. A.**, Superconducting transition temperature of superimposed films, 17: 5139
**SIMMS, John C.**, Polarographic test for solvent quality. II., 17: 4456 (DP-772)
**SIMNAD, M. T.**, High-temperature materials for nuclear applications. I., 17: 4969
**SIMON, H.**, Measurement of weak $\beta$ emitters in gas phase, 17: 4817
**SINCLAIR, W. Robert**, Controlled multicomponent sputtering, 17: 4892
**SINGER, L. S.**, ESR in polycrystalline graphite, 17: 4529
**SINGER, Paul**, Decay mode $\omega \to 2\pi + \gamma$, 17: 5244
**SINGER, S. F.**, Photoelectric screening of bodies in space, 17: 5166
**SINGER, S. Fred**, Effects of trapped particles on geomagnetic field, 17: 4704
**SINNOTT, M. J.**, Phase equilibria in C–O–U, 17: 4518
**SISMAN, O.**, Reactor materials, 17: 5041 (ORNL-3364(p.151-200))
**SITTE, Kurt**, Cherenkov radiation from extensive air showers, 17: 5197
**SKORUPSKI, A.**, Electromagnetic fields in case of moving media, 17: 5535
**SKOWRONEK, Maurice**, Passage of high-intensity current, 17: 5450
**SLAUS, I.**, Reaction V$^{51}$(n,d)Ti$^{50}$ at 14.4 Mev, 17: 5385
**SLIEMERS, F. A.**, Grafting of vinyl pyrrolidone to polymethylmethacrylate by pre-irradiation techniques. I., 17: 4580 (TID-7643 (p.185-98))
**SLOTH, E. N.**, Tritium in fission of U-235, 17: 5337
**SMART, Richard**, Improvements in position-indicating apparatus, 17: 5592
**SMIRNOVA, E. K.**, Enthalpy of Nb oxytrichloride, 17: 4550
**SMITH, C. F., Jr.**, Distortion of proportional counter spectra, 17: 4853
**SMITH, J.**, Pressure vessel reactor designs, 17: 5611
**SMITH, Kenneth**, Scattering of electrons and positrons, 17: 5278
**SMITH, Lawrence B.**, Wind measurements in the mesodecline, 17: 4701
**SMITH, Peter Roy**, Improvements in retarding devices, 17: 4652
**SMITH, R. B.**, Quasi-elastic scattering by H$_2$O, 17: 5297 (HW-75147)
**SMITH, Robert Roy**, Radiation grafting of acrylonitrile, 17: 4619
**SMOLDERS, C. A.**, Colloid and surface chemistry, 17: 4516
**SNIEGOSKI, P. J.**, Properties of Ce and Fe compounds, 17: 4450
**SNOW, William R.**, Final rpt. on analysis of ionized gases, 7/62, 17: 4457 (GA-3358)
**SOBOLEV, N. N.**, Spectrum of Si irradiated by fast neutrons, 17: 5010
**SOBUE, Hiroshi**, Radiation-induced polymerization of copolymers, 17: 4611
**SOBUE, Hiroshi**, Radiation-induced polymerization of acrylonitrile, 17: 4612
**SODA, Toshio**, Macroscopic electrostatic and magnetostatic energy, 17: 5203 (UCRL-6499)
**SODHA, M. S.**, Propagation of amplitude-modulated EM wave in plasma, 17: 5509
**SODHA, Mahendra Singh**, Nonlinear propagation of EM waves in plasma, 17: 5506
**SOERENSEN, Gunner**, Alpha-induced fission of Si-28, 17: 5369
**SOKOLOV, V. V.**, Myelopoiesis in x rays and benzole intoxication, 17: 4403
**SOLOVIEVA, E. A.**, Myelopoiesis in x rays and benzole intoxication, 17: 4403
**SOLTIS, Fred S.**, Rocket for particulate sampling of clouds, 17: 4692 (UCRL-13054)
**SOMERS, E. V.**, Forced-convective flow in vertical tubes, 17: 4673
**SOPKOVICH, N. J.**, Annihilations $\bar{N}N \to \bar{K}K$ and $\bar{Y}Y$, 17: 5221
**SOSIN, A.**, Dislocation pinning in Cu, 17: 4996
**SOUTHERN, A. L.**, Sputtering with 1- to 5-kev Ar$^+$ ions, 17: 5089
**SOUTO, Jose**, Tumor development induced by blood of irradiated rats, 17: 4409
**SPANIER, J.**, Multigroup calculation of absorption rates, 17: 4882
**SPANNER, J. C.**, Tube-to-tube annulus in reactor, 17: 4689
**SPARRMAN, P.**, Lifetime of 129-kev level in Ir-191, 17: 5408
**SPARROW, E. M.**, Laminar heat transfer in tubes, 17: 4676
**SPEDDING, F. H.**, Rare-earth alloy systems. I., 17: 4981
**SPEDDING, F. H.**, Thermodynamic properties of La, Pr, Eu, Yb, and Y, 17: 4929 (IS-327)
**SPEHL, H.**, Producing neutral atomic H beam, 17: 5117
**SPEJEWSKI, E. H.**, Beta spectrum of Mn-56, 17: 5387
**SPIERLING, H.**, Measurement of thermal neutron flux, 17: 4825
**SPINRAD, B. I.**, State nuclear technology, 1/62, 17: 4376 (TID-14912)
**SPODE, Ernst**, Radiation protection. Tabular survey, 17: 4430
**SRIVASTAVA, O. K.**, Differential thermal analysis of oxalates, 17: 4543
**SRIVASTAVA, P. K.**, Lee model with two V particles, 17: 5563
**STADLER, H. L.**, Attenuators for high-frequency pulses, 17: 4791
**STAFFORD, G. H.**, Efficiencies for detecting neutrons in organic scintillators, 17: 4836
**STAHLKE, J. L.**, ESR magnetometer for time-varying fields, 17: 5425
**STALEY, D. O.**, Mass and radioactivity transport from stratosphere to troposphere, 17: 4699
**STAMM, R. F.**, Radiation grafting of chloromethylstyrene to polypropylene, 17: 4590 (TID-7643(p.345-97))
**STAMPER, J. G.**, Absorption spectrum of DBr, 17: 4508
**STANNERS, W.**, Pressure tube reactors, 17: 5612
**STANNETT, V.**, Radiation-induced grafting to cellulose, 17: 4585 (TID-7643(p.259-67))
**STANOCH, Andrzej**, Contamination of grass by Sr-90, 17: 4392
**STAPP, Henry P.**, Axiomatic S-matrix theory, 17: 5569
**STARR, E.**, Diffusion cooling in graphite, 17: 5293 (BNL-5987)
**STARR, Eugene**, Diffusion hardening in water, 17: 5308
**STASILEVICH, Z. K.**, Influence of radiation on immunity to measles, 17: 4401
**STEBLER, Alfred**, Controllable ionization chamber, 17: 4870
**STEELE, Edgar L.**, Fast neutron activation analysis, 17: 4479
**STEFANESCU, Alexandru**, Measurements of neutron fluxes in WWS-reactor, 17: 5582
**STEHR, H.**, Flat and curved monochromator crystals in neutron spectrometers for investigating single crystals, 17: 4775 (NP-tr-923)
**STEIN, Gabriel**, Electrons in irradiated aqueous solutions, 17: 4602
**STEINBERG, M. A.**, Research in space materials, 17: 4985
**STEINBERG, Meyer**, Gamma polymerization of ethylene, 17: 4574 (TID-7643(p.70-106))
**STEPANENKO, I. Z.**, Expansion of a circular cylindrical tube subjected to dynamic loads, 17: 4642 (UCRL-Trans-876(L))
**STEPHAN, Elmer F.**, Solubility of LiOH and H$_2$O, 17: 4520
**STEPHEN, M. J.**, Classical approximation in Thomas-Fermi theory, 17: 5267
**STONE, Orville L.**, Radioactive borehole logging apparatus, 17: 4865
**STONEHILL, D.**, Properties of the $\eta$ meson, 17: 5259
**STONEHILL, D. L.**, Interactions in $\pi^+$-p collisions, 17: 5279
**STOPPINI, G.**, Photoproduction of muon pairs in C, 17: 5260
**STORER, John B.**, Radiation response as index of aging in mice, 17: 4418
**STRAKA, R. M.**, Decametric wave-length absorption from nuclear explosion, 7/9/62, 17: 5116
**STRAUMANN, N.**, Removal of ghost state in Lee model, 17: 5556
**STRICK, H. A.**, Decametric wave-length absorption from nuclear explosion, 7/9/62, 17: 5116
**STROFFOLINI, R.**, Equation for high-energy cross sections, 17: 5225
**STROME, W. M.**, Magnetic disturbance from nuclear explosion, 17: 5104
**STRONG, K. A.**, Phasing two choppers from motor-generator source, 17: 4838
**STROOT, J. P.**, DISC: Cherenkov counter with velocity selection, 17: 4826
**STROOT, J. P.**, DISC counter with liquid radiator, 17: 4827
**STROUGH, M. Clarus**, Thermal decomposition of oxalates and carbonates, 17: 4553
**STROUP, R. S.**, New graphites engineering materials, 17: 4968
**STRUMANE, R.**, Smakula's formula for F-center concentrations, 17: 5032 (BLG-123)
**STUDIER, M. H.**, Tritium in fission of U-235, 17: 5337
**SUBBOTIN, V. I.**, Critical heat loads in forced flow of water, 17: 4662 (AEC-tr-5538)
**SUESS, H. E.**, Radiocarbon dating of deep water, 17: 4713
**SUGIURA, Toshio**, Effects of $\gamma$ radiation on glass, 17: 5022
**SULLIVAN, R. J.**, Reprocessing irradiated UO$_2$ fuel, 17: 4628 (NAA-SR-

7136)

**SUMI, Yoshio,** Resonances in terms of compound states, 17: 5268

**SUN, Peng-Joung,** Solvent extraction of Th with thiocyanate, 17: 4631

**SUNDARESAN, M. K.,** Kinetic equation of plasma in weak fields, 17: 5446

**SUNDARESAN, M. K.,** Kinetic equation of plasma in strong field, 17: 5447

**SUNDSTROEM, T.,** Lifetime of 129-kev level in Ir-191, 17: 5408

**SUNG, Baik Nung,** Energy spectrum of photoprotons from Ne-20, 17: 5345

**SURDIN, M.,** Propagation of ultrasonic waves in plasmas, 17: 5490

**SUTTON, David C.,** Positron decay of Sc-42, V-46, Mn-50, Co-54, and Cu-58, 17: 5325 (PUC-1962-62)

**SUWA, Shigeki,** Dee voltage stabilizer, 17: 5417

**SUYDAM, B. R.,** Stability of plasma torus not dependent on azimuth, 17: 5440 (TID-13633)

**SUZUKI, Arata,** Dee voltage stabilizer, 17: 5417

**SUZUKI, Arata,** Synchrocyclotron oscillator pulser circuit, 17: 5418

**SUZUKI, Hideo,** Boltzmann transport equation and boundary value, 17: 5539

**SUZUKI, Hiromichi,** Gamma-induced conductivity of CdSe, 17: 5005

**SUZUKI, K.,** Radiation hygiene in U mines, 17: 4747

**SVECHNIKOV, V. N.,** Phase diagram of Cr–Ni–$Ni_3Nb$–NbCr, system, 17: 4978

**SVERDLOV, L. M.,** Anharmonicity constants of polyatomic molecules, 17: 4546

**SVIRIDOV, N. K.,** Protective reactions in radiation sickness, 17: 4439

**SWENNEY, D. M. C.,** Raman spectrum of ethane-$d_6$, 17: 5073

**SWIFT, C. D.,** L-shell fluorescence yields of Pt, Tl, and Pb, 17: 5135

**SZABOVA, Katerina,** Autoinfection after total-body lethal irradiation, 17: 4433

**SZYDLOWSKI, Jerzy,** Irradiation of nervous system of Albino rats, 17: 4393

**SZYMANSKI, Z.,** Spurious state in $\beta$ vibration of nuclei, 17: 5381

# T

**TABATA, Yoneho,** Radiation-induced polymerization of acetylene, 17: 4610

**TABATA, Yoneho,** Radiation-induced polymerization of copolymers, 17: 4611

**TABATA, Yoneho,** Radiation-induced polymerization of acrylonitrile, 17: 4612

**TADIC, D.,** Anomalous shape in allowed $\beta$ spectra, 17: 5370

**TADMOR, J.,** Fuel temperature increase following "loss of coolant" accident, 17: 5583

**TAGLIATI, S.,** Meteorological information for reactor startup, 17: 4694

**TAKAHASHI, K.,** Orbit flip magnetic transitions, 17: 5350

**TAKAHASHI, Kikuo,** Surveying for radioactive substances, 17: 4861

**TAKEDA, Susumu,** Microwave reflection by plasmas, 17: 5451

**TAKEI, W. J.,** Magnetic properties of $FeTiO_3$–$\alpha Fe_2O_3$, 17: 4959

**TALMAN, R. M.,** Photoproduction of $\pi^0$ from H, 17: 5253

**TALWAR, S. P.,** Stability of hard-core fluid jet, 17: 5453

**TANAKA, Eiii,** Giant resonance in $Al^{27}(\gamma,n)$, 17: 5341

**TANAKA, Eiii,** Reactions $P^{31}(\gamma,n)$ and $S^{32}(\gamma,n)$, 17: 5342

**TANAKA, Hirobumi,** Effects of $\gamma$ radiation on glass, 17: 5022

**TANAKA, Shigetoshi,** Negative radiation temperature at resonance in cold plasmas, 17: 5461

**TANDON, J. N.,** Stability of hard-core fluid jet, 17: 5453

**TANENBAUM, B. Samuel,** Wave propagation in partly ionized gas, 17: 5468

**TANGHERLINI, F. R.,** Poincaré compensating stresses for classical point electron, 17: 5551

**TANNER, Maurice Charles,** Improvements in mixer-settler, 17: 4797

**TANTTILLA, W. H.,** Interruption of nuclear spin diffusion, 17: 4531

**TARPINIAN, Aram,** Microstructures of pyrolytic graphite, 17: 4954

**TASMAN, Herman Abel,** Ion optics of mass spectrometers, 17: 4796

**TASSAN, S.,** Conversion ratios in slightly enriched U, $H_2O$-moderated lattices, 17: 5576 (BNL-5985)

**TATE, R. E.,** Fabrication of billets containing Pu, 17: 4918

**TATI, T.,** Structure of elementary particles, 17: 5209

**TAU, L.,** Photoproduction of muon pairs in C, 17: 5260

**TAYLOR, E. H.,** Surface properties of silica gel, 17: 5026

**TAYLOR, Hugh P., Jr.,** Origin of tektites, 17: 5093

**TAYLOR, Lauriston S.,** Physical Foundations of Radiology, 3rd Ed., 17: 4431

**TAYLOR, M. D.,** Preparation of lanthanide halides, 17: 4542

**TAYLOR, Richard Edward,** Production of $\pi^+$ by polarized bremsstrahlung, 17: 5291

**TEDROW, P. M.,** Melting curves of $He^3$–$He^4$ mixtures, 17: 5144

**TERA, F.,** Separation of U, Th, and Bi, 17: 4478

**TERRALL, J. R.,** Inelastic scattering and Boltzmann equation, 17: 5205 (UCRL-6559-T)

**TETENBAUM, Marvin,** Uranium powder ignition studies, 17: 4972

**TEUFER, G.,** Crystal structure of tetragonal $ZrO_2$, 17: 4504

**THARMALINGAM, K.,** Absorption of phonons by electron gas, 17: 5118

**THEIMER, Otto H.,** Bremsstrahlung emission and electric conductivity in plasma, 17: 5429 (AD-275288)

**THEISEN, R.,** Nickel as diffusion barrier between U and Al, 17: 4926 (EUR-17.f)

**THOM, K.,** Measuring electrical conductivity, 17: 4786

**THOMAS, D. H.,** Analytic approach to two-dimensional reactor theory, 17: 5312

**THOMAS, David,** Calibration of $T(d,n)He^4$ yield from positive ion accelerator, 17: 5412 (NDL-TM-6)

**THOMAS, David Gerney Arnold,** Precipitation of fission decay products from gases, 17: 5600

**THOMAS, G. E.,** Boron-loaded liquid scintillation neutron detector, 17: 4839

**THOMAS, G. E.,** Neutron detection with glass scintillators, 17: 4835

**THOMPSON, Theos J.,** Neutron dosimetry, spectrometry, and activation analysis, 17: 4807 (MITNE-8)

**THOMSON, S. J.,** Thin-walled cylindrical G-M counter, 17: 4823

**THRESHER, J. J.,** Efficiencies for detecting neutrons in organic scintillators, 17: 4836

**THURBER, D. L.,** Variations in ratio $U^{234}/U^{238}$, 17: 4718

**THURBER, David L.,** Anomalous $U^{234}/U^{238}$ in nature, 17: 5096

**TIBURTIUS, Heinfried,** Radiation protection for lens of eye, 17: 4441

**TIERNAN, Thomas O.,** Rare-gas sensitized radiolysis of propane, 17: 4601

**TILLES, D.,** Radioactivities in meteorites, 17: 4708

**TING, Chen-hanson,** Oxidation potential of cerous–ceric electrode, 17: 4539

**TITLEY, Spencer R.,** Color centers in fluorite, 17: 5094

**TOKUHIRO, H.,** Effects of thorotrast, 17: 4414

**TOLLER, M.,** Fast-triggering system for spark chambers, 17: 4856

**TOLLER, M.,** Neutrinoless coherent nuclear capture of $\mu^-$ mesons, 17: 5377

**TOLLESTRUP, A. V.,** Photoproduction of $\pi^0$ from H, 17: 5253

**TOLSTOI, N. A.,** Spectra of alkali earth metal fluorides, 17: 5125

**TOMAS, P.,** Reaction $V^{51}(n,d)Ti^{50}$ at 14.4 Mev, 17: 5385

**TOMITA, Shigeharu,** Protons from several elements, 17: 5339

**TONG, B. Y.,** Huby's rules for Rayleigh-Schroedinger perturbation theory, 17: 5567

**TONKIN, James Henry,** Converting solution of radioactive salt into solid, 17: 4620

**TOROPOV, N. A.,** Stabilization of dicalcium silicates, 17: 4548

**TRAPEZNIKOVA, Z. A.,** Flash mechanism of SrS phosphors, 17: 5049 (UCRL-Trans-853(L))

**TRASKUNOVA, N. V.,** Prophylactic stimulation of thrombocytopoiesis during ionizing radiation, 17: 4436

**TREFILOV, V. I.,** Formation of $\omega$ phase in Hf alloys, 17: 4979

**TREIBS, H. A.,** Band structure of $CaF_2$:Mn, 17: 5033 (HW-70230)

**TRIFONOV, E. D.,** Integral representation for Coulomb Green function, 17: 4884

**TRUMP, John G.,** Electrons for surgical materials sterilization, 17: 4762

**TSANG, Tung,** Analysis of NMR line shapes by lattice harmonics, 17: 5134

**TSERKOVNITSKAYA, I. A.,** Determination of Zr, 17: 4474

**TSUKISHIMA, Takeshige,** Microwave reflection by plasmas, 17: 5451

**TUCEK, J.,** Interactions of fast pions with nuclei, 17: 5214

**TUCK, D. G.,** Solubility of Hg in water, 17: 4451

**TUERPE, D. R.,** Fission tracks in AgCl crystals, 17: 5082

**TULUB, A. V.,** Energy and excitations for interacting Fermi fields, 17: 5155

**TURBERFIELD, K. C.,** Dynamics of liquid Na by neutron scattering, 17: 4976

**TURCOTTE, Donald L.,** Diffusion in one-dimensional pinch, 17: 5474

**TURKEVICH, Anthony L.,** Radioactivity induced in Discoverer 17, 17: 5098

**TURNBULL, W.**, Interaction of microwaves with exploding wires, 17: 5480
**TURNER, E. B.**, Prog. rpt. on MHD turbulence, 7-12/61, 17: 5435 (DCAS-TDR-62-45)
**TURRELL, George C.**, Zirconium-arc infrared source, 17: 4793
**TYTGAT, D.**, Nickel as diffusion barrier between U and Al, 17: 4926 (EUR-17.f)

## U

**UCHIDA, Teijiro**, Instabilities for azimuthal pinched plasma, 17: 5462
**UETA, Masayasu**, Luminescence of x-rayed alkali halide, 17: 5112
**ULEHLA, I.**, Particles with two mass states, 17: 5213
**ULLMAN, J.**, Proton polarization in scattering by O-16 and C-12, 17: 5349
**UNSER, Klaus**, Controllable ionization chamber, 17: 4870
**UNTERBERGER, R. R.**, Magnetic effects of nuclear explosion, 17: 5105
**UO, Koji**, Spatial confinement of plasma, 17: 5475
**UPSON, U. L.**, Scintillating glasses for α counting, 17: 4806 (HW-SA-2191)
**UTSUGI, H.**, Desorption of Cs from W, 17: 4525

## V

**VAHLDIEK, F. W.**, Phase transformation of $ZrO_2$, 17: 4519
**VAILE, P. E. B.**, Lubricants for nuclear reactors, 17: 4957
**VALLETTA, R. M.**, Rare-earth alloy systems. I., 17: 4981
**VAN ALLEN, J. A.**, Electrons in outer radiation zone, 17: 5183
**VAN DE GRAAFF, R. J.**, High-voltage acceleration tubes, 17: 5420
**VAN DE HULST, H. C.**, Gaunt factors for Maxwellian electron gas, 17: 5512
**VANDERKOOI, William N.**, Separating Tb and Y values, 17: 4637
**VAN DER MEULEN, D.**, Scattering of 14.8-Mev neutrons from C and Bi, 17: 5359
**VAN DILLA, Marvin A.**, Gamma rays in space, Ranger 3, 17: 5185
**VAN KLEEF, Th. A. M.**, Slater parameters for Hf III spectrum, 17: 5148
**VAN KRANENDONK, J.**, Infrared spectrum of solid H, 17: 5071
**VAN MIEGHEM, J.**, Advances in Geophysics, Vol. 9, 17: 4703
**VANN, H. E.**, Effects of reactor core parameters on plant cost, 17: 5625
**VASIL'EV, S. S.**, Decay of C-12 caused by α particles, 17: 5361
**VATSEK, A.**, Gas exchange changes in rats following administration of cystein and cysteamine, 17: 4437
**VAVILOV, V. S.**, Spectrum of Si irradiated by fast neutrons, 17: 5010
**VEBENOV, A. A.**, Drift of carriers in solid state, 17: 4982
**VEIGELE, Wm. J.**, Nuclear magnetic dipole moment of Ca-41, 17: 5390
**VEKSLER, V. I.**, Energy spectra of Rb and Cs ions scattered by Mo, 17: 5154
**VELIKOV, E. P.**, Drift of carriers in solid state, 17: 4982
**VENTURINO, A. J.**, High-field superconducting solenoid, 17: 4781
**VERHOEVEN, John D.**, Mobilities in liquid Bi alloys, 17: 4946
**VERONESI, P.**, Internal Compton effect, 17: 5123
**VER PLANCK, D. W.**, Gas-cooled reactors for high-temperature steam plants, 17: 5623
**VESELOV, M. G.**, Exchange in adiabatic approximation in atom theory, 17: 5156
**VICENTINI, G.**, Dioxane addition compounds, 17: 4452
**VICENTINI-MISSONI, M.**, Diffusion coefficient in mixtures of He-3 in He-II, 17: 5122
**VINCENT, P. C.**, Viability of Ehrlich ascites tumor cells, 17: 4410
**VINCOW, G.**, Paramagnetic resonance of rare earth ions, 17: 5030 (AFOSR-2114)
**VINEYARD, G. H.**, Departures from Vegard's law, 17: 4955
**VITOVEC, F. H.**, Superalloys under combined stress at elevated temperatures, 17: 4965
**VLASOV, V. G.**, Effects of alkali metal carbonates on $UO_2$ reduction, 17: 4622
**VOGELL, W.**, Enrichment of C-13, 17: 4871 (AEC-tr-5526)
**VOJTISKOVA, Marta**, Transplantation therapy in lethally irradiated mice, 17: 4432
**VOLKOV, D. V.**, Coulomb excitation of Λ particles, 17: 5286
**VON EGIDY, Till**, Double-focusing β spectrometer, 17: 4812
**VOORHIES, H. G.**, Interaction between plasma and external current and flux, 17: 5504
**VOROB'EVA, O. V.**, Effect of γ radiation on conducting films, 17: 5019
**VRESTAL, J.**, Gravimetric methods for Ru based on hydrolysis, 17: 4463
**VRILLON, Bernard**, Improvements in reactor cooling systems, 17: 5599

## W

**WABER, J. T.**, Corrosion of Pu, 17: 4908
**WACHSPRESS, E. L.**, Iteration parameters for model problem, 17: 4880
**WAGNER, C. D.**, Radiation-induced polymerization of α-olefins, 17: 4573 (TID-7643(p.56-69))
**WAGNER, C. D.**, Radiolysis of liquid propylene, 17: 4617
**WAGNER, William G.**, M meson and generalization of Pomeranchuk relations, 17: 5250
**WAGONER, G.**, ESR in polycrystalline graphite, 17: 4529
**WAKITA, Hitoshi**, Mathematical framework of quantum theory. II., 17: 5269
**WAKIYAMA, Tokuo**, Magnetostriction of Gd, 17: 4961
**WAKIYAMA, Tokuo**, Thermal expansion of Gd, 17: 4962
**WALD, Adolph**, Brazing and soldering of metals, 17: 4917
**WALKER, B. E., Jr.**, Specific heat of materials, 17: 4523
**WALKER, Bruce R.**, Rocket for particulate sampling of clouds, 17: 4692 (UCRL-13054)
**WALKER, E. H.**, Photoelectric screening of bodies in space, 17: 5166
**WALKER, R. M.**, Etching of charged particle tracks in solids, 17: 4999
**WALKER, R. M.**, Observations of charged particle tracks in solids, 17: 4998
**WALKER, R. W.**, Radioactive filter bank fire detection systems, 17: 4772 (RFP-253)
**WALKER, William L.**, Materials of construction in fuels separations facilities, 17: 4627 (HW-SA-2810)
**WALL, E. M. Vander**, Thermal decomposition of hydrated Fe, Cr, and Ni nitrates, 17: 4492 (IDO-14597)
**WALLER, Milton M.**, Thermoelectric system, 17: 4801
**WALLERSTEIN, George**, Experiments relevant to peculiar Star 3 Centauri, 17: 5178
**WALLGREN, Kenneth**, Preliminary assignment of Si-28 excited states, 17: 5321 (BRL-Memo-1392)
**WALSH, William J.**, Radioisotopic measurement of cavitation and erosion damage, 17: 4971
**WALTER, T. A.**, Quenching of scintillation solution by $O_2$, 17: 4566
**WALTON, J. D.**, Final rpt. on high-temperature ceramic structures, 11/1/61–10/31/62, 17: 4931 (NP-12306)
**WARD, J. W.**, Neutralization of ion beams, 17: 5647
**WARNER, Benjamin Frank**, Converting solution of radioactive salt into solid, 17: 4620
**WARRIKHOFF, Harald**, Pocket dosimeter, 17: 4869
**WARTEL, William S.**, Dispersion-strengthened Ni alloy, 17: 4967
**WATABE, Atsuko**, Spin structures in heavy rare earth metals, 17: 5401
**WATABE, Mitsuo**, Transport coefficients of quantum plasma, 17: 5510
**WATANABE, Haruhiko**, Radiation-induced copolymerization, 17: 4613
**WATANABE, Masayuki**, Ternary system $PbO-TiO_2-ZrO_2$, 17: 4963
**WATERBURY, G. R.**, X-ray absorption edge of Co, 17: 4462
**WATERBURY, Glenn R.**, Separation of Pu by Anion exchange, 17: 4629
**WATSON, K. M.**, Detection of nuclear explosions, 17: 5061
**WATT, W. S.**, Radiolysis of aqueous systems, 17: 4614
**WEATHERWAX, J. L.**, Physical Foundations of Radiology, 3rd Ed., 17: 4431
**WEAVER, R. S.**, Excited states in Xe-131 and Pb-208, 17: 5335
**WEBB, Maurice Stephen William**, Spectrographic analysis apparatus and process, 17: 4487
**WEBB, R. L.**, Radiation-induced ionic polymerization of butadiene, 17: 4575 (TID-7643(p.109-17))
**WEBB, Robert John**, Spectrographic analysis apparatus and process, 17: 4487
**WEBER, A. H.**, Mirror-point distributions of trapped particles, 17: 5182
**WECHSLER, M. S.**, Radiation metallurgy, 17: 5040 (ORNL-3364(p.125-50))
**WEGNER, H. E.**, Reaction ($He^3$,t), 17: 5391
**WEIMER, Katherine E.**, Equilibrium and stability for systems with small curvature, 17: 5438 (MATT-89)
**WEINBERG, A. F.**, Final rpt. on carbides for thermionic space reactors, 5/15–8/31/62, 17: 5577 (GA-3523)
**WEINBERGER, Jan V.**, Shield for ionizing radiation, 17: 5529
**WEINSTEIN, R.**, Decay of $K^+$, 17: 5202 (TID-14840)
**WEINSTOCK, H.**, Melting curves of $He^3-He^4$ mixtures, 17: 5144
**WEIR, C. E.**, High-pressure transition in RbF, 17: 4536
**WEISMANTEL, E. E.**, Properties of Be sheet metal, 17: 4914
**WEISS, R. J.**, Image of Fermi surface in lead, 17: 5146
**WEISSBERG, Harold L.**, Viscous flow through porous media. II., 17: 4679
**WELLS, D.**, Interaction between plasma and dipole, 17: 5477

**WELSH, H. L.**, Raman spectrum of ethane-$d_6$, 17: 5073
**WENDT, I.**, Age determination of U minerals, 17: 4710
**WENK, G. J.**, Cosmic ray threshold rigidities, 17: 5190
**WENTWORTH, Robert C.**, Effects of trapped particles on geomagnetic field, 17: 4704
**WESS, J.**, Solution for Thirring model, 17: 5546
**WESTON, Ralph E., Jr.**, Isotope effects in chemical reactions, 17: 5063
**WHAPHAM, A. D.**, Fission fragment tracks in $UO_2$, 17: 4974
**WHEATFALL, Walter**, Prog. rpt. on oxidation resistance of $NbAl_3$, 9/62–11/62, 17: 4903 (DRI-2075)
**WHEATFALL, Walter L.**, Prog. rpt. on oxidation resistance of $NbAl_3$, 9/61–8/62, 17: 4902 (DRI-2061)
**WHITE, A. M.**, Prog. rpt. on dies for extrusion of steels and refractory alloys, 6/15/62–9/15/62, 17: 4911 (NMI-9700.3)
**WHITE, F. A.**, Reversed-biased p-n junctions, 17: 4787
**WHITEHAIR, Leo Anthony**, Characteristics of irradiated pork muscle, 17: 4767
**WHITNEY, D. R.**, Determination of lattice parameters, 17: 4490 (GAT-T-1052)
**WHITNEY, D. Ransom**, Lattice parameter of Si, 17: 4489 (GAT-T-1051)
**WHITNEY, E. D.**, Solubility of $SrSO_4$ in water, 17: 4466
**WIEDEMANN, W.**, Hyperfine structure splitting of $\gamma$ lines. V., 17: 5406
**WIEGAND, Clyde E.**, Pion-pion interactions, 17: 5252
**WIEGAND, D. A.**, Expansion of alkali halide crystals, 17: 5018
**WILDY, Peter Charles**, Spectrographic analysis apparatus and process, 17: 4487
**WILEY, David S.**, Instabilities of liquid conductor, 17: 4681
**WILEY, W. C.**, Continuous-channel electron multiplier, 17: 4792
**WILKINSON, D. H.**, Rutherford Memorial Lecture, 1962. Interrelations of nuclear structure, 17: 5395
**WILKINSON, M. K.**, Crystal physics, 17: 5037 (ORNL-3364(p.27-56))
**WILKINSON, M. K.**, Neutron diffraction, 17: 5059
**WILLARD, D.**, Internal conversion in I-132 decay, 17: 5371
**WILLIAMS, David William**, Improvements in reactor fuel elements, 17: 5590
**WILLIAMS, Ffrancon**, Radiation-induced polymerization of cyclopentadiene, 17: 4576 (TID-7643(p.118-26))
**WILLIAMS, G. C.**, Measuring plasma jet temperatures, 17: 5443 (WADD-TR-60-676(Pt.II))
**WILLIAMS, J. A.**, Neutron flux from point source in air, 17: 5294 (BRL-Memo-1432)
**WILLIAMS, R. L.**, Fast high-sensitivity Si photodiodes, 17: 4646
**WILLIAMS, R. L.**, Solid state charged particle Si detectors, 17: 4804 (ARL-62-406)
**WILLIAMS, R. V.**, Electron density in Sceptre IV, 17: 5463
**WILLIAMS, S. A.**, Model for deformed even nuclei, 17: 5331
**WILLIS, Conrad P.**, Beryllium content of meteorites, 17: 4698
**WILLIS, William R.**, Sputtering with 1- to 5-kev $Ar^+$ ions, 17: 5089
**WILLS, Stanley Charles Frederick**, Charge chutes for nuclear reactors, 17: 5593
**WILSON, A. S.**, Amines as extractants—organic phase, 17: 4626 (HW-SA-2797)
**WILSON, A. T.**, Electrostatic acceleration in upper atmosphere, 17: 5095
**WILSON, Theodore A.**, Structure of MHD waves, 17: 5488
**WILSON, Thomas W.**, Final rpt. on thermal precipitator, 5/15/59–5/15/62, 17: 4641 (TID-17378)
**WINAND, L.**, Cross sections for $Li^6(n,t)He^4$, 17: 5338
**WINCKLER, J. R.**, Solar flare x-ray burst, 17: 5091
**WINCKLER, J. R.**, Van Allen outer radiation regions, 17: 5184
**WINGATE, Catherine L.**, Determination of absorbed dose from x rays, 17: 4850
**WINSTON, A. W.**, Preparation of wood–plastic combinations using radiation, 17: 4589 (TID-7643(p.335-44))
**WINTER, Jacques-Michel**, Production of beam of polarized particles, 17: 5076
**WISHLADE, J. L.**, Thin-walled cylindrical G-M counter, 17: 4823
**WISNIEWSKI, Artur**, Producing ZnS scintillator for $\alpha$ detector, 17: 4847
**WITHERS, J. C.**, Coating large refractory metal parts, 17: 4964
**WITTEN, L.**, Conformal invariance in physics, 17: 5572
**WITTENBERG, L. J.**, Density of molten Pu, 17: 4944
**WITTKOWER, A. B.**, High-voltage acceleration tubes, 17: 5420
**WITTMANN, A.**, Pyrophorous alloys, 17: 4935 (AEC-tr-5545)
**WOLF, Fred A.**, Coherent scattering of photons by atomic H, 17: 5137
**WOLICKI, E. A.**, Angular correlations for $C^{12}(He^3,\alpha\gamma)C^{11}$, 17: 5372
**WOLLAN, E. O.**, Neutron diffraction, 17: 5059
**WONG, Wen-Kuei**, Photochemical reduction of uranyl sulfate, 17: 4606
**WOODRUFF, E. M.**, Radiation effects on carbons and graphites, 17: 4989 (HW-SA-2368)
**WORT, D. J. H.**, Solar temperature at 2-mm wave length, 17: 5175
**WORTMAN, D. E.**, Beta spectrum of Mn-56, 17: 5387
**WRIGHT, E. S.**, Corrosion of Pu, 17: 4908
**WRIGHT, J. H.**, Nuclear heat sources for steam turbines, 17: 5622
**WU, T. Y.**, Irreversible processes in gases, 17: 5075
**WU, Ta-You**, Kinetic equation of plasma in weak fields, 17: 5446
**WU, Ta-You**, Kinetic equation of plasma in strong field, 17: 5447
**WUERKER, R. F.**, Plasmoid dipole rotation in theta pinch, 17: 5495
**WYBOURNE, B. G.**, Nuclear moments and intermediate coupling, 17: 4528
**WYLER, Oswald**, Differential topology and algebraic structures, 10/62, 17: 4878 (TID-17355)
**WYTZES, Shoerd**, Device for x-ray spectrochemical analysis, 17: 4799

## Y

**YADAVALLI, S. V.**, Final rpt. on interaction of EM waves with plasma, 4/62, 17: 5431 (AFCRL-62-185)
**YAGODA, Herman**, Radiation studies in space with emulsion detectors, 17: 5194
**YAGUDINA, F. R.**, Photoproduction of $\pi^+$ mesons, 17: 5287
**YAMADA, Kazuo**, Electric fields in space and time, 17: 5151
**YAMADA, Takenobu**, Dee voltage stabilizer, 17: 5417
**YAMADA, Takenobu**, Synchrocyclotron oscillator pulser circuit, 17: 5418
**YAMADA, Y.**, Radiation hygiene in U mines, 17: 4747
**YAMADA, Yasumasa**, Protons from several elements, 17: 5339
**YAMAGUCHI, K.**, ESR of electron-irradiated cycloheptatriene, 17: 4604
**YAMAKI, Tetsuji**, Protons from several elements, 17: 5339
**YAMAMOTO, Kunio**, Baryon number conservation, 17: 5270
**YAMANOUCHI, Mikio**, Discrimination of charged particles, 17: 5110
**YAMASHITA, Yoshihiko**, Plasma in Kr discharge, 17: 5460
**YANG, H. T.**, Moment equations and boundary conditions for magnetogasdynamics, 17: 5129
**YANG, Kwang-Tzu**, Convection of liquids in tubes, 17: 4675
**YANG, L.**, Final rpt. on carbides for thermionic space reactors, 5/15–8/31/62, 17: 5577 (GA-3523)
**YANINA, L. V.**, Labor hygiene and industrial sanitation, 17: 4751
**YANKO, W. H.**, Prog. rpt. on organic coolants, 4/1–5/30/62, 17: 5578 (IDO-11002)
**YARIS, Robert**, Polarizability change in liquids, 17: 4526
**YGUERABIDE, Juan**, Luminescence decay times, 17: 4565
**YNTEMA, J. L.**, Alpha scattering by Zn-64 and Zn-68, 17: 5358
**YOCKEY, Hubert P.**, Radiation damage and ferroelectric effect in Rochelle salt, 17: 5003
**YOKOSAWA, Akihiko**, Beam from duoplasmatron proton source, 17: 5153
**YOKOTA, Hideshi**, Adsorption of $H_2O$ on LiF, 17: 4545
**YONEZAWA, Minoru**, Lepton energy spectra in $K^+_{e3}$-decay, 17: 5275
**YOSHIDA, Shiro**, Vibrational states of spherical nuclei, 17: 5365
**YOSHIKAWA, H. H.**, Radiation effects on carbons and graphites, 17: 4989 (HW-SA-2368)
**YOSHIKAWA, H. H.**, Radiation behavior of graphite materials, 17: 4990 (HW-SA-2814)
**YOSHIKAWA, Shoichi**, Electric conductivity of turbulent plasma, 17: 5472
**YOSHIMOTO, Hiroshi**, Plasma in Kr discharge, 17: 5460
**YOSIDA, Kei**, Spin structures in heavy rare earth metals, 17: 5401
**YOUMANS, Arthur H.**, Scintillation counter, 17: 4863
**YOUNG, D. M.**, Physical adsorption of gases, 17: 5159
**YOUNG, F. W., Jr.**, Dislocations in annealed and irradiated Cu crystals. I and II., 17: 5002
**YOUNG, F. W., Jr.**, Metals, 17: 5038 (ORNL-3364(p.57-84))
**YOUNG, K. M.**, Electron density in Sceptre IV, 17: 5463
**YPSILANTIS, Thomas**, Pion-pion interactions, 17: 5252

## Z

**ZACHAROV, B.**, Axially symmetric magnetic fields for image tube systems, 17: 4784
**ZADUBAN, M.**, Autoinfection after total-body lethal irradiation, 17: 4433

**ZAEHRINGER, J.**, K–Ar measurements of tektites, 17: 4711
**ZAJAC, Adolf**, Contamination of grass by Sr-90, 17: 4392
**ZAKHARIEVSKII, M. S.**, Diffusion coefficients in $SrCl_2$ solutions, 17: 4549
**ZALEWSKI, K.**, Classical approximation in Thomas-Fermi theory, 17: 5267
**ZANDER, K.**, Electronic control of boiling-down procedure, 17: 4783
**ZARNOWIECKI, Krzysztof**, Producing ZnS scintillator for α detector, 17: 4847
**ZARNOWIECKI, Krzysztof**, Producing standard radioactive sources for calibrating dosimeters, 17: 5009
**ZASTAWNY, A.**, Construction of $CO_2$ proportional counters, 17: 4860
**ZEIDMAN, B.**, Alpha scattering by Zn-64 and Zn-68, 17: 5358
**ZENGER, J. H.**, Gamma rays from interaction of 14-Mev neutrons with Li, 17: 5357
**ZENKEVICH, B. A.**, Critical heat loads in forced flow of water, 17: 4662 (AEC-tr-5538)
**ZERBY, C. D.**, Collimator study for 5-Gev electron beam, 17: 5413 (ORNL-TM-423)
**ZHUKOVSKII, V. M.**, Effects of alkali metal carbonates on $UO_2$ reduction, 17: 4622
**ZIFFERERO, M.**, Amine extraction of $HNO_3$, 17: 4453
**ZUBKE, D.**, Reactions $O^{16}$(d,p) and (d,α) at 0.8 to 2.0 Mev, 17: 5367
**ZURAWSKA, Janina**, Contamination of grass by Sr-90, 17: 4392

# SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries. A more complete description of the patterns and style of indexing used is included in the introductions to the subject index cumulations that are issued quarterly.

As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number in that volume. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Published literature (journal article or book) is identifiable by the absence of a report number.

## A

**ABSORPTION SPECTRA**
  of photosynthetic organisms, evaluation of techniques for determining, 17: 4380(R) (UCRL-10479)
**ACCELERATOR TUBES**
  design of high-voltage, using inclined-field principles, 17: 5420
**ACCELERATORS**
  development of heavy-ion, review of, 17: 5062
  shielding materials and requirements for, review of, 17: 5057
**ACETIC ACID, (ETHYLENEDIAMINE) TETRA- COMPLEXES**
  with iron, square wave titrimetric end point of, 17: 4486
**ACETONE**
  radioinduced oxidation in aqueous sulfuric acid solution, mechanism and kinetics of, 17: 4600
  scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602
**ACETONITRILE**
  radioinduced polymerization of, mechanism of, 17: 4609
**ACETYLENE**
  anharmonicity constants of isotopically substituted, 17: 4546(T)
  formation in rare gas sensitized radiolysis of labeled propane, 17: 4601
  radioinduced polymerization of liquid and solid, 17: 4610
**ACIDS**
  dissolution of, in amines, 17: 4626 (HW-SA-2797)
  hydrogen isotope exchange with 1,3-dimethoxybenzene, 17: 4560 (TID-17369)
**ACRYLAMIDE**
  radioinduced polymerization of, in solutions with propionamide effects of oxygen on, 17: 4577 (TID-7643(p.127-35))
**ACRYLIC ACID ESTERS**
  effects on radioinduced crosslinking of polymers, 17: 4584 (TID-7643 (p.245-58))
**ACRYLIC ACID, ETHYL ESTER**
  radioinduced polymerization in wood, 17: 4589 (TID-7643(p.335-44))
  radioinduced polymerization in aqueous emulsions, 17: 4596
**ACRYLIC ACID, METHYL ESTER**
  radioinduced graft polymerization with polymers, 17: 4583 (TID-7643 (p.233-44))
  radioinduced polymerization of, in solid state, 17: 4578 (TID-7643(p.136-49))
  radioinduced polymerization in aqueous emulsions, 17: 4596
**ACRYLIC ACID POLYMERS**
  radioinduced graft polymerization with polyethylene, 17: 4591 (TID-7643(p.398-413))
**ACRYLONITRILES**
  radioinduced graft polymerization with polyethylene in vacuum, effects of pre-irradiation on, 17: 4607
  radioinduced graft polymerization with polypropyrene in vacuum, effects of pre-irradiation on, 17: 4607
  radioinduced graft copolymerization of, 17: 4619(P)
  radioinduced polymerization of, in solid state, 17: 4578 (TID-7643(p.136-49))
  $C_3H_3N-C_2H_4$, radioinduced polymerization of, 17: 4612
  $C_3H_3N-C_4H_6O$, radioinduced polymerization of, 17: 4613
  $C_3H_3N-C_3H_6O$, radioinduced polymerization of, 17: 4613
**ACTINIC RADIATIONS**
  interactions of, in the ionosphere, 17: 5029 (AFCRL-62-623)
**ACTINIUM ISOTOPES Ac-227**
  determination in radium-223, 17: 4374(R) (MLM-1129)
**ACTIVATION ANALYSIS**
  development of techniques for, 17: 4807 (MITNE-8)
  method using fast neutrons, 17: 4479
  review, 17: 4484
  review of neutron, 17: 4470
  use of TRIGA reactor in, 17: 4483
**ADHESIVES**
  development and evaluation, 17: 4374(R) (MLM-1129)
  properties of room-temperature-cured, 17: 4375(R) (MLM-1133)
  tensile properties, 17: 4374(R) (MLM-1129)
**ADRENAL GLANDS**
  radiation effects on adrenocortical-hypophyseo function, 17: 4406
**ADSORPTION**
  book: *Physical Adsorption of Gases*, 17: 5159
**AEROSOLS**
  identification and sampling methods, 17: 4703
**AGE ESTIMATION**
  by variations in the ratio of uranium-234 to uranium-238, 17: 4718
  of basaltic lava using alpha activity and thermoluminescence, 17: 4712
  of rocks by strontium isotopes, 17: 4706
  of secondary uranium minerals in northern Bavaria, 17: 4710
  of tektites by potassium–argon method, 17: 4711
  of uraninites in Yugoslavia by lead isotopes, 17: 4709
  using fission processes, 17: 4707
**AIR**
  corrosive effects on plutonium, 17: 4908
  electron conductivity in x-ray-ionized, 17: 5072
  ionization, conference, 17: 4379
  monitoring for plutonium and uranium, design of apparatus for, 17: 4811
  radioactivity measurement, 17: 4814
  reactions of dry and wet, with lithium, 17: 4522
  shock waves in, ionization rates behind, 17: 5131
**ALBUMINS**

labeling of human serum, with bromine-82, 17: 4387

**ALKALI METAL HALIDE CRYSTALS**

radiation effects on dimensional stability at room temperature, 17: 5018

**ALKALI METAL HALIDES**

radiation effects on luminescence, 17: 5039(R) (ORNL-3364(p.85-124))

**ALKENES**

radioinduced polymerization of alpha-, mechanisms for, 17: 4573 (TID-7643(p.56-69))

**ALLOYS**

brazing and soldering, 17: 4917(T)

corrosion of, bibliography on, 17: 4904 (LAMS-2779)

crystal properties of binary, concentration effects on, 17: 4955

development of ferrous and non-ferrous, for nuclear technological uses, 17: 4973

**ALPHA PARTICLES**

backscattering from surfaces, 17: 5100

detection and measurement in calibration of Cockcroft-Walton Accelerator, 17: 5412 (NDL-TM-6)

detection and measurement, development of scintillating glasses for, 17: 4806 (HW-SA-2191)

detection and measurement of, solid-state monitor for, 17: 4840

detection and tracking of, in layer-structure crystals, 17: 4998

effects on high catalase mutant and wild-type *Rheudopseudomonas spheroides*, lethal, 17: 4416

fission of neon-20 by, carbon-12 distributions from, 17: 5368

fission of silicon-28 by, cross sections for symmetric, 17: 5369

interactions with nucleons, separable-potential model for, 17: 5216

reactions $(\alpha,4\alpha)$ on carbon-12, mechanisms for, 17: 5361

reactions with nuclei $(\alpha,n)$, 17: 5396

scattering by nuclei, inelastic, 17: 5382

scattering by nuclei, inelastic, 17: 5383

scattering by thin targets, proton angular distributions from, 17: 5339

scattering by zinc-64 and -68, distributions from, 17: 5358

**ALPHA SOURCES**

monitoring in air, equipment for, 17: 4811

**ALTIMETERS**

sensitivity of radiometric, 17: 4777

**ALUMINUM**

abundance in peculiar magnetic stars, 17: 5178

alpha reactions $(\alpha,p)$ at 30 Mev, angular distributions from, 17: 5339

analysis of very pure, for impurities by radioactivation, 17: 4480

casting, 17: 4910(R) (MAB-139-M(C7))

cesium ion reactions on, negative-ion yields from, 17: 5087

dynamic yield behavior of explosively loaded, 17: 4949

gamma reactions $(\gamma,p)$ at 24 Mev, proton spectra of, 17: 5340

inspection of tubes of, eddy current techniques for, 17: 4689

radiation effects on dislocation damping in, fast-neutron, 17: 5013

radiation effects on pure, reactor-neutron, 17: 5001

separation by electrophoresis on zirconium phosphate paper, 17: 4467

separation from plutonium by anion exchange, quantitative, 17: 4629

shielding properties of, in high-energy accelerators, 17: 5057

sputtering of, by argon ions, 17: 5038(R) (ORNL-3364(p.57-84))

viscosity of, relation of atomic mobility to, 17: 4945

**ALUMINUM ALLOYS**

analysis for uranium, x-ray fluorescence, 17: 4459 (GAT-T-1053)

Al–Cu, radiation effects on atomic rearrangement, 17: 5040(R) (ORNL-3364(p.125-50))

Al-Li, phase diagram of, 17: 4930 (NMI-7010)

Al–Nb, oxidation resistance, effect of metallic additions on, 17: 4902(R) (DRI-2061)

Al–Nb, phase equilibria of, 17: 4902(R) (DRI-2061)

Al–Nb–Ti, oxidation resistance, effect of metallic additions on, 17: 4903(R) (DRI-2075)

Al–Ni–U, radiation effects on, at high temperatures, 17: 5023

Al–Pu, fabrication for MTR fuel elements, 17: 4918

Al–Pu, phase diagram, 17: 4984

**ALUMINUM FILMS**

electron inelastic scattering by thin, theory for, 17: 5281(T)

particle track production in, by fission fragments, 17: 5017

**ALUMINUM ISOTOPES**

helium-3 elastic scattering by, optical model for, 17: 5364

**ALUMINUM ISOTOPES Al-26**

decay gamma energies, 17: 5376

separation from meteorites, 17: 4717

**ALUMINUM ISOTOPES Al-27**

gamma reactions $(\gamma,n)$ at 12.5 to 24 Mev, cross sections of, 17: 5341

helium nucleus reactions (helium-3,t), spectra from, 17: 5391

proton reactions $(p,\gamma)$, gamma energy measurement, 17: 5321 (BRL-Memo-1392)

**ALUMINUM ISOTOPES Al-28**

half life, 17: 5352

**ALUMINUM NITRATES**

thermal decomposition of nonahydrate of, 17: 4492 (IDO-14597)

**ALUMINUM OXIDE CRYSTALS**

radiation effects on thermoluminescence of, gamma, 17: 4997

**ALUMINUM OXIDE FILMS**

radiation effects on, on glass, 17: 5020

**ALUMINUM OXIDES**

analysis of colloidal, for sodium by neutron activation, 17: 4482

brazing, 17: 4912(R) (ORNL-TM-413)

vaporization and viscosity, 17: 4933 (WADD-TR-60-463(Pt.II))

$Al_2O_3$–CaO, fusion energy measurement of, 17: 4950

$Al_2O_3$–$SiO_2$, viscosity, 17: 4933 (WADD-TR-60-463(Pt.II))

**AMIDE POLYMERS**

radioinduced graft polymerization with methyl acrylate styrene, effects of methanol on, 17: 4583 (TID-7643(p.233-44))

**AMINES**

solvent properties for acids and metals, 17: 4626 (HW-SA-2797)

**AMMONIA**

effects on radioinduced polymerization of cyclopentadiene at −78°C, 17: 4576 (TID-7643(p.118-26))

reactions with halogen-acid off-gases in scrub tower, 17: 5648

**AMMONIA TANKS QUADRANGLE (NEV.)**

geologic map of, 17: 4732

**AMMONIUM CHLORIDES**

excretory effects on cesium-137 in rats, 17: 4391

**AMMONIUM CHROMATES**

neutron capture by, chromium in, chemistry of, 17: 4595

**ANALYSIS**

bibliography on, of reactor materials, 17: 4461 (JAERI-4023)

of uranium, literature review, 17: 4485

**ANIMAL CELLS**

effects of incorporated chromium-51 on viability, 17: 4410

radiosensitivity of, effects of 5-chlorodeoxyuridine on, 17: 4411

**ANISOLE**

hydrogen, isotope exchange with acids, 17: 4560 (TID-17369)

**ANTHRACENE**

fluorescence quenching in cyclohexane solution of, by oxygen, 17: 4566

**ANTHRACENE, DIPHENYL-**

luminescence quenching in benzene solution, effects of aromatic halides on, 17: 4563

luminescence quenching by organometallics in benzene and cyclohexane solution, 17: 4564

**ANTIFERROMAGNETIC MATERIALS**

magnetic properties of non-ferrous, review, 17: 4966

neutron scattering by uniaxial, distributions from, 17: 5318(T)

theory of, with cubic clusters of spins, 17: 5027 (AD-273950)

**ANTIHYPERONS**

interactions with nucleons, selection rules for annihilation, 17: 5289

**ANTIMONY**

viscosity of, relation of atomic mobility to, 17: 4945

**ANTIMONY ALLOYS**

Sb–In, sputtering by argon ions at 1 to 5 kev, yields, 17: 5089

**ANTIMONY COMPOUNDS**

organic, luminescence quenching effects on diphenylanthracene and p-tetraphenyl in benzene and cyclohexane solutions, 17: 4564

**ANTIMONY ISOTOPES**

mass measurement of, absolute, 17: 5333

neutron separation energies, 17: 5333

**ANTINUCLEONS**

interactions with nucleons, angular distributions of, 17: 5221

**ANTIPROTONS**

interactions with protons at 3 to 30 Bev/c, Regge pole model of, 17: 5255 interactions with protons at 1.61 Bev/c, annihilation, 17: 5273

**ARAGONITES**

synthesis of labeled, 17: 4540

**ARGON**

diffusion in potassium halides, 17: 4927(R) (EURAEC-312)

diffusion in potassium salts of aliphatic acids, 17: 4927(R) (EURAEC-312)

diffusion of krypton-85 in, 17: 4524

electron transport in ionized, effects of nitrogen impurity on, 17: 5515

hydrogen ion splitting cross sections for, 17: 5117

polarizability of liquid, corrections for zero-field many-body, 17: 4526

radiolysis effects on labeled and unlabeled propane, 17: 4601

reactions of dry and wet, with lithium, 17: 4522

reactions with carbon monoxide and nitrogen at high pressure, spectra of, 17: 4527

reactions with graphitized carbon black, gas-surface, 17: 4534

**ARGON IONS**

detection and tracking of, in silicate crystals, 17: 4999

sputtering reactions with aluminum, copper, and zinc, 17: 5038(R) (ORNL-3364(p.57-84))

sputtering yields at 1 to 5 kev, 17: 5089

**ARGON ISOTOPES**

fractionation in gaseous absorption, 17: 4511

helium-3 elastic scattering by, optical model for, 17: 5364

**ARGON ISOTOPES Ar-37**

occurrence in meteorites and recovered satellites, 17: 4708

**ARGON ISOTOPES Ar-39**

occurrence in meteorites, 17: 4708

**ARGON ISOTOPES Ar-40**

content in tektites, 17: 4711

**ARSENIC**

determination of traces in marine organisms, activation, 17: 4468

electric conductivity effects on copper–zirconium alloys, 17: 4938

**ARSENIC ISOTOPES As-75**

proton reactions (p,xp) at 100 to 400 Mev, cross sections for, 17: 5323 (NYO-8921)

**ASTROPHYSICS**

hydrodynamic models of solar corona, 17: 5169

interface between solar wind and geomagnetic field, stability of, 17: 5173

interface between solar wind and geomagnetic field, 17: 5174

relations of auroral and ionospheric disturbances to solar activity, 17: 5047(T) (AD-275256)

**ATMOSPHERE**

abundance of radiogenic xenon-129 in, 17: 5171

auroral and ionospheric disturbances in, relation to solar activity, 17: 5047(T) (AD-275256)

circulation of, properties and processes at the Earth's surface in relation to, 17: 4703

helium isotope concentrations in, escape mechanism for, 17: 5095

helium triplet metastable atoms in, content, 17: 5149

particle precipitation in, thermal, 17: 4641 (TID-17378)

radio-wave attenuation in earth's, effects of high-altitude nuclear explosions on, 17: 5044 (RM-3391-PR)

ratio of xenon-129 to xenon-136 in, 17: 5172

solar-cycle variation of upper, models for, 17: 5170

**ATOMIC BEAMS**

production of hydrogen, by ion splitting in argon, 17: 5117

scattering of, extrema velocities of total elastic cross sections for, 17: 5090

use in studying electronic and nuclear properties of rare earths, 17: 5403

**ATOMIC ENERGY COMMISSION**

nuclear power program, report to the President, 17: 5631

**ATOMIC EXPLOSIONS**

detection of, review, 17: 5061

effects on radio-wave attenuation in earth's atmosphere, 17: 5044 (RM-3391-PR)

genetic effects in Hiroshima and Nagasaki populations, first-generation, 17: 4381

interaction with geomagnetic field, electromagnetic signal from, 17: 5099

radioactivity due to, airborne, 17: 4746

**ATOMIC PHYSICS**

iteration-variation method for atomic scattering, 17: 5565

**ATOMIC STRUCTURE**

crystal exchange potential theory, 17: 5147

**ATOMS**

electronic structure of, positron annihilation studies of, 17: 5200 (IS-299)

energy of univalent, exchange correction for adiabatic approximation of, 17: 5156

energy ranges of, in solids, hard-sphere approximation of, 17: 5036(R) (ORNL-3364(p.1-26))

transitions in hydrogenlike, effect of quadrupole moments on forbidden, 17: 5124(T)

x-radiation scattering by, dispersion corrections for, 17: 5045 (TID-14794)

# B

**BACTERIA**

effects of feeding irradiated coliform, on growth of transplanted tumors in mice, 17: 4408

hydrogen peroxide and alpha radiation effects on high catalase mutant and wild-type *Rheudopseudomonas spheroides*, 17: 4416

isolation of radioresistant mutant of *Staphylococcus aureus*, 17: 4384

radiation effects on infiltration of, in blood and organs in dogs, 17: 4433

radiosensitivity of *Clostridium botulinum*, 17: 4394

**BARIUM**

reactions with benzophenone, spin distributions in, 17: 4535

separation from plutonium by anion exchange, quantitative, 17: 4629

sorption by zirconium oxides, effects of previous hydrogen adsorption on, 17: 4500(T) (AEC-tr-5529)

**BARIUM FLUORIDE CRYSTALS**

spectra of europium and ytterbium in, absorption and luminescence, 17: 4547(T)

**BARIUM FLUORIDES**

spectra of uranium-activated, relaxation luminescence, 17: 5125(T)

**BARIUM OXIDES**

thermionic emission in, shallow donor, 17: 5079

**BARIUM PERCHLORATES**

reactions with dioxane, structure of addition compound formed in, 17: 4452

**BASES**

radioinduced extinction modification of, effect of DNA macrostructure on, 17: 4618

**BELGIAN REACTOR-2**

operation of, correlation of parameters in, 17: 5574 (BLG-119)

**BENZENE**

polymerization effects in methacrylic acid grafting to polyethylene, 17: 4608

toxic effects on hematopoietic system, 17: 4403

**BENZENE, BROMO-**

luminescence quenching effects on scintillator solutions in benzene and cyclohexane, 17: 4563

**BENZENE, CHLORO-**

luminescence quenching effects on scintillator solutions in benzene and cyclohexane, 17: 4563

**BENZENE, DIBROMO-**

luminescence quenching effects on scintillator solutions in benzene and cyclohexane, 17: 4563

**BENZENE, ETHYNYL-**

radioinduced polymerization of, mechanism of, 17: 4609

**BENZENE, FLUORO-**

fluorine-18 retention by, in solutions, 17: 4603

luminescence quenching effects on scintillator solutions in benzene and cyclohexane, 17: 4563

**BENZENE, IODO-**

luminescence quenching effects on scintillator solutions in benzene and cyclohexane, 17: 4563

**BENZOIC ACID, FLUORO-**

fluorine-18 retention by, in solutions, 17: 4603

**BENZOIC ACID, SODIUM SALTS**

chemical effects on radioinduced reactions of methylene blue, 17: 4592 (TID-14927)

**BENZOPHENONES**
  reactions with metals, spin distributions in, 17: 4535
**BERYLLIUM**
  casting, 17: 4910(R) (MAB-139-M(C7))
  cesium ion reactions on, negative-ion yields from, 17: 5087
  content in meteorites, 17: 4698
  deformation of sheets and tubes under complex stressing, 17: 4970
  deposition of plastic films, 17: 4374(R) (MLM-1129)
  deposition on plastic films, 17: 4375(R) (MLM-1133)
  determination in the atmosphere, spectrographic, 17: 4487(P)
  extrusion of silver-coated, 17: 4919(P)
  gamma reactions $(\gamma,p)$, polarization of protons from, 17: 5389
  mechanical properties of, effects of surface damage on, 17: 4937
  meson $(\mu^-)$ lifetimes and capture in, 17: 5324 (NYO-9286)
  neutron diffusion in, effect of Bragg cutoff on thermal, 17: 5316
  production of, having increased high-temperature ductility, 17: 4988(P)
  radioinduced hydrogen agglomeration in, 17: 4941
  removal of, from cathode of electrolytic cell, 17: 4656(P)
  removal of, from electrolytic cells, 17: 4655(P)
  tensile properties of, effects of rolling parameters on, 17: 4914
  thermal capacity at 30 to 800°C, 17: 4523
**BERYLLIUM ALLOYS**
  thermal capacity at 30 to 800°C, 17: 4523
  Be–Cu–Ti, properties as brazing alloy, 17: 4912(R) (ORNL-TM-413)
  Be–Pu, phase diagram, 17: 4984
  Be–Ti–Zr, properties as brazing alloy, 17: 4912(R) (ORNL-TM-413)
**BERYLLIUM FILMS**
  electron inelastic scattering by thin, theory for, 17: 5281(T)
**BERYLLIUM ISOTOPES Be-8**
  energy levels from deuteron reactions with lithium-6, 17: 5322 (NP-12258)
  energy levels of, 17: 5361
**BERYLLIUM ISOTOPES Be-9**
  gamma reactions $(\gamma,p)$ at 16.89 to 57 Mev, cross sections and yields of, 17: 5410
  nuclear excitation by 180° electron scattering, 17: 5388
**BERYLLIUM ISOTOPES Be-10**
  separation from meteorites, 17: 4717
**BERYLLIUM OXIDES**
  corrosion by water vapor at high temperatures, 17: 4897
  neutron lifetimes in, 17: 5299 (LA-2743)
  radiation effects on sintering of, 17: 4899
  thermal capacity at 30 to 800°C, 17: 4523
  BeO–CaO, fusion energy measurement of, 17: 4950
  $BeO-Li_2O$, fusion energy measurement of, 17: 4950
**BERYLLIUM PERCHLORATES**
  reactions with dioxane, structure of addition compound formed in, 17: 4452
**BETA DECAY**
  beta-gamma circular polarization correlations in forbidden, measurement, 17: 4830
  renormalization of axial constants in, 17: 5201 (JINR-P-1051)
  theory of anomalous spectra in allowed, 17: 5370
  theory of inverse, lepton, 17: 5272
  vector interactions in, theory of, 17: 5400
**BETA PARTICLES**
  detection and measurement of low-energy, design of Geiger-Mueller counter for, 17: 4823
  detection and measurement, double-focusing spectrometer for, 17: 4844
  dosimetry of, determination of G-values for ferrous sulfates in, 17: 4597
  dosimetry using lucite, depth-dose, 17: 4851
  effects on rats, protective effects of drugs against, 17: 4438
  measurement in gases, review, 17: 4817
  scattering of, use in gas density gages, 17: 4777
**BETA SOURCES**
  development of krypton-85, for soft gamma radiography, 17: 4688
  dosimetry and techniques for, for external contact therapy, 17: 4383
  performance with solid organic phosphors, as standard light sources, 17: 4789
**BETA SPECTRA**
  theory of anomalous, in allowed decays, 17: 5370
**BETA SPECTROMETERS**
  description of two-fold focusing $2\pi\sqrt{2}$, 17: 4834
  design and performance of double-focusing, 17: 4844
  design of double-focusing, 17: 4812
  performance of guard-ring silicon surface-barrier detectors as, 17: 4855
  performance of lithium-drifted semiconductor, for energies below 100 kev, 17: 4857
**BETATRONS**
  beam acceleration and control, 17: 5414
  calibration and control of 23 Mev, 17: 5426
  field parameter calculation for electron injection into plasma, 17: 5421
  magnetic field measurement in, time-varying, 17: 5425
**BIBLIOGRAPHIES**
  analysis of reactor fuels and materials, 17: 4461 (JAERI-4023)
  on activation analysis, 17: 4484
  on analytical chemistry of uranium, 17: 4485
  on beta ray measurement in gases, 17: 4817
  on colloid and surface chemistry, 17: 4516
  on corrosion of metals and alloys, 17: 4904 (LAMS-2779)
  on cosmic radiation effects in meteorites, 17: 5060
  on cryogenics, 17: 5065
  on detection of nuclear explosions, 17: 5061
  on ferromagnetism and antiferromagnetism in non-ferrous metals and alloys, 17: 4966
  on geology of salt deposits in United States, 17: 4705
  on heavy-ion accelerators, 17: 5062
  on industrial uses of radioisotopes, 17: 5064
  on inorganic toxicology, 17: 4388
  on isotopes produced by cosmic rays in meteorites, 17: 4693
  on isotopic effects in chemical reactions, 17: 5063
  on isotopic exchange reactions, 17: 4494 (SCR-512)
  on neutron activation analysis, 17: 4470
  on neutron-capture gamma rays, 17: 5058
  on nuclear orientation, 17: 5056
  on nucleon-nucleon interaction potentials, 17: 5055
  on physical adsorption of gases, 17: 5159
  on shielding requirements in high-energy accelerators, 17: 5057
  on solid hydrides, 17: 4551
  on strong interactions of hyperons and mesons, 17: 5054
  on technetium in nature, 17: 4449
  on thermal neutron diffraction, 17: 5059
**BIG ROCK POINT POWER REACTOR**
  development program for, 17: 5624
**BIOLOGICAL MATERIALS**
  analysis of marine organisms for trace elements, activation, 17: 4468
**BIPHENYL**
  fluorescence quenching in cyclohexane solution of, by oxygen, 17: 4566
  radiolysis of labeled and unlabeled, effects of liquid-solid phase transition on hydrogen yield in, 17: 4605
  thermodynamic properties, 17: 5578(R) (IDO-11002)
**BISMUTH**
  electric mobility of metals in liquid, at 500°C, 17: 4946
  separation from thorium and uranium by anion exchange, 17: 4478
  viscosity of, relation of atomic mobility to, 17: 4945
**BISMUTH ALLOYS**
  Bi–Pb, corrosive effects on ferritic steels by eutectic melt of, 17: 4906
  Bi–Pu, phase diagram, 17: 4984
**BISMUTH ISOTOPES Bi-205**
  production in lead by solar protons, 17: 5098
**BISMUTH ISOTOPES Bi-207**
  electron and photon spectra of, below 1 Mev, 17: 4857
  internal conversion in, electron spectra from, 17: 4855
**BISMUTH ISOTOPES Bi-209**
  neutron inelastic scattering by, distributions from, 17: 5359
**BISMUTH SELENIDES**
  purification, 17: 5039(R) (ORNL-3364(p.85-124))
**BISMUTH TELLURIDES**
  radiation effects on electric properties, 17: 5039(R) (ORNL-3364(p.85-124))
**BLADDER**
  radiotherapy of carcinomas of, effectiveness of, 17: 4385
**BLOOD**
  carcinogenic effects of, from irradiated animals, 17: 4409
  radiation effects on bacteria infiltration into, in dogs, 17: 4433

**BLOOD CELLS**
radiosensitivity of, in dogs, mice, and rabbits, 17: 4405
**BLOOD DISEASES**
spontaneous leukosis, effects of cortisone and x radiation in mice, 17: 4396
**BLOOD PLASMA**
therapeutic effects of placental, on radiodermatitis, 17: 4435
**BLOOD PLATELETS**
stimulation by diphacyl in radiation sickness in guinea pigs, 17: 4436
**BLOOD SERUM**
labeling of albumin, fibrinogen, and insulin with bromine-82, 17: 4387
**BOILERS**
design for pressurized water reactors, 17: 5632(P)
design of, for heat recovery from pressurized fluid, 17: 4684(P)
**BOILING**
effects on heat transfer in tubes, 17: 4663(T) (AEC-tr-5539)
heat transfer in forced-convection film, on plate with uniform surface heat flux, 17: 4677
**BOILING REACTORS**
design and development of high power density, 17: 5624
design of 300-Mw(e) high-power-density, 17: 5607 (GEAP-3860)
**BOMB DAMAGE SURVEYS**
mortality of Nagasaki survivors from malignant neoplasms, 17: 4404
**BONES**
radiation dosimetry of soft tissues near, 17: 4850
radiation effects on calcium-45 storage, 17: 4425
radiation injuries to, from therapy of neoplasms in early childhood, 17: 4400
**BORON**
diffusion into graphite, production of dislocation loops by, 17: 4956
gamma reactions (γ,p), polarization of protons from, 17: 5389
**BORON COATINGS**
deposition of, on refractory metals, 17: 4964
**BORON ISOTOPES**
abundance ratios in meteorites, 17: 5097
**BORON ISOTOPES B-10**
excited state of, lifetime of first, 17: 5353
meson ($\mu^-$) lifetimes and capture in, 17: 5324 (NYO-9286)
nuclear excitation by 180° electron scattering, 17: 5388
**BORON ISOTOPES B-11**
energy levels of, unified model for, 17: 5362
meson ($\mu^-$) lifetimes and capture in, 17: 5324 (NYO-9286)
nuclear excitation by 180° electron scattering, 17: 5388
**BORON NITRIDES**
thermal capacity at 30 to 800°C, 17: 4523
**BORON OXIDES**
$B_2O_3$–CaO, fusion energy measurement of, 17: 4950
**BOROSILICATE GLASS**
characteristics for neutron detection, 17: 4835
**BOSONS**
collective treatment of many-body systems, 17: 5566
condensation in many-body systems of, simple and generalized, 17: 5557
internal energy of a system of, 17: 5119
mass of vector, bare, 17: 5226
partition function of a system of, 17: 5119
perturbation theory of many-body systems of, 17: 5561
properties of the matrix $\beta_5$ relative to the theory of, with spin 1, 17: 5265
**BRAIN**
environmental effects on cholinesterase activity, hexokinase activity, and protein content of rat, 17: 4561(R) (UCRL-10350)
**BRAKES**
design of, for decelerating drums, 17: 4652(P)
**BRAZING**
electron beam use in, 17: 4921(P)
processes in, 17: 4917(T)
**BRAZING ALLOYS**
composition and properties, 17: 4917(T)
for ceramics, 17: 4912(R) (ORNL-TM-413)
**BREMSSTRAHLUNG**
contribution to radiation dose in space vehicles, 17: 5646
dosimetry using lucite, depth-dose, 17: 4851
emission by plasma, effects of correlations on incoherent, 17: 5502
polarization of, mesons ($\pi^+$) production in, 17: 5291
reactions with carbon, muon-pair photoproduction in, 17: 5260
**BRITISH REACTORS**
development of submarine pressurized-water, 17: 5613
development of submarine pressurized-water, 17: 5614
**BROMINE ISOTOPES**
helium-3 elastic scattering by, optical model for, 17: 5364
**BROMINE ISOTOPES Br-82**
labeling of human serum albumin, fibrinogen, and insulin with, 17: 4387
**BROOKHAVEN SYNCHROTRON**
shielding of, 17: 5057
**BUCKBOARD MESA QUADRANGLE (NEV.)**
geologic map of, 17: 4730
**BUTADIENE**
radioinduced polymerization of, effects of added materials, 17: 4575 (TID-7643(p.109-17))
**1-BUTANOL, 3-METHYL-**
solvent properties for thorium in thiocyanate, 17: 4631
**BUTYL PHOSPHATES**
butyl phosphate-hexane, extraction of water into, 17: 4634
$HNO_3$–TBP–$H_2O$, molecular interactions in, 17: 4446 (IS-500(Sect.E))
hydrocarbon–TBP, polarographic behavior, 17: 4456 (DP-772)
solvent properties of tri-, for phosphoric acid and water, 17: 4454

## C

**CABLES**
design of, for driving cryotron circuits, 17: 4788
**CADMIUM**
cesium ion reactions on, negative-ion yields from, 17: 5087
radiation effects, 17: 5038(R) (ORNL-3364(p.57-84))
radiation effects on pure, reactor-neutron, 17: 5001
shielding properties of, in high-energy accelerators, 17: 5057
viscosity of, relation of atomic mobility to, 17: 4945
**CADMIUM CHLORIDES**
spectra in argon, krypton, and xenon matrices, infrared, 17: 4497 (UCRL-10451)
**CADMIUM ISOTOPES**
energy levels of, theory of low-lying vibrational, 17: 5365
helium-3 elastic scattering by, optical model for, 17: 5364
**CADMIUM OXIDE FILMS**
radiation effects on, on glass, 17: 5020
**CADMIUM PERCHLORATES**
reactions with dioxane, structure of addition compound formed in, 17: 4452
**CADMIUM SELENIDE CRYSTALS**
radiation effects on electric conductivity of, gamma, 17: 5005
**CADMIUM SULFIDE CRYSTALS**
radiation effects on electric conductivity of, gamma, 17: 5005
**CALCIUM**
reactions with benzophenone, spin distributions in, 17: 4535
viscosity of, relation of atomic mobility to, 17: 4945
**CALCIUM FLUORIDE CRYSTALS**
spectra of europium and ytterbium in, absorption and luminescence, 17: 4547(T)
spectra of manganese-activated, band structure of, 17: 5033 (HW-70230)
**CALCIUM FLUORIDES**
spectra of uranium-activated, relaxation luminescence, 17: 5125(T)
**CALCIUM ISOTOPES**
energy levels of, theory of low-lying vibrational, 17: 5365
**CALCIUM ISOTOPES Ca-41**
nuclear magnetic dipole spin resonance, 17: 5390
**CALCIUM ISOTOPES Ca-45**
radiation effects on storage of, by bones in mice, 17: 4425
**CALCIUM NITRATES**
calcium-41 nuclear magnetic spin resonance in, 17: 5390
**CALCIUM OXIDES**
$Al_2O_3$–CaO, fusion energy measurement of, 17: 4950
BeO–CaO, fusion energy measurement of, 17: 4950
$B_2O_3$–CaO, fusion energy measurement of, 17: 4950
**CALCIUM PERCHLORATES**

reactions with dioxane, structure of addition compound formed in, 17: 4452
**CALCIUM SILICATES**
$Ca_2SiO_4$–$Y_4(SiO_4)_3$, phase studies and structure, 17: 4548
**CALDER HALL REACTORS**
loading systems for Hinkley Point, 17: 5620
moderator stored energy, 17: 5014
physics program for Bradwell number 1, 17: 5587
**CAMERAS**
design of high-speed rotating-mirror framing, 17: 4776
operation of, development of two-channel regulating delay circuit for, 17: 4785
**CAMP DESERT ROCK QUADRANGLE (NEV.)**
geologic map of, 17: 4721
**CANDU REACTOR**
description and performance of, 17: 5612
description of, 17: 5619
**CANE SPRING QUADRANGLE (NEV.)**
geologic map of, 17: 4720
**CARBON**
bremsstrahlung reactions ($\gamma$, 2$\mu$), 17: 5260
deposition during hydrocarbon pyrolyses, kinetics and mechanisms of, 17: 4514
gamma reactions ($\gamma$,p), polarization of protons from, 17: 5389
meson ($\mu^-$) lifetimes and capture in, 17: 5324 (NYO-9286)
metabolism during photosynthesis, 17: 4390
radiation effects on pyrolytic, 17: 4990 (HW-SA-2814)
shielding properties of, in high-energy accelerators, 17: 5057
**CARBON BLACK**
reactions with xenon at 2700°C, third-order gas-surface, 17: 4534
**CARBON COATINGS**
deposition and properties on carbide fuels, 17: 4888 (GA-3109)
**CARBON DIOXIDES**
diffusion from commercial graphite at 1000°C, 17: 4986
diffusion of krypton-85 in, 17: 4524
performance as proportional-detector filler gas, effects of oxygen content on, 17: 4853
reactions of dry and wet, with lithium, 17: 4522
reactions with water, effects of pressure and temperature on isotopic fractionation in, 17: 4511
uptake by *Chlorella* in dark following preillumination, tracer studies, 17: 4380(R) (UCRL-10479)
**CARBON ISOTOPES**
fractionation between aqueous and gaseous carbon dioxide, effects of physical changes on, 17: 4511
fractionation in gaseous absorption, 17: 4511
fractionation in synthesis of diamonds, 17: 4511
helium-3 reactions on, optical model for, 17: 5364
**CARBON ISOTOPES C-12**
alpha reactions ($\alpha$,4$\alpha$) at 22 to 24 Mev, mechanisms for, 17: 5361
meson ($\mu^-$) capture by, probability of, 17: 5409
neutron inelastic scattering by, distributions from, 17: 5359
nuclear excitation by 180° electron scattering, 17: 5388
production in symmetric alpha fission of neon-20, 17: 5368
proton elastic scattering by, polarization effects in, 17: 5349
proton reactions (p,2p) on, spectra from, 17: 5362
**CARBON ISOTOPES C-13**
helium-3 reactions ($He^3$,$\alpha\gamma$) on, angular correlations from, 17: 5372
separation from other carbon isotopes, operation of chemical exchange plant for, 17: 4871(T) (AEC-tr-5526)
separation from other carbon isotopes by chemical exchange, conditions for operation of cascade for, 17: 4872(T) (AEC-tr-5527)
**CARBON ISOTOPES C-14**
content in Indian and Pacific Oceans, 17: 4713
effects of labeling on stability of fructose, mannose, and ribose, 17: 4599
recovery of, from ion accelerators, 17: 4561(R) (UCRL-10350)
**CARBON MONOXIDES**
diffusion from commercial graphite at 1000 and 1800°C, 17: 4986
force constants from molecular orbitals, 17: 5108
reactions with rare gases at high pressure, spectra of, 17: 4527
thermal decomposition by hot wire, 17: 4375(R) (MLM-1133)
**CARBON SULFIDES**
effects on radioinduced polymerization of butadiene, 17: 4575 (TID-7643(p.109-17))
**CARBON SYSTEMS**
development of, for nuclear technological uses, 17: 4973
C–Fe, stress relaxation, 17: 5040(R) (ORNL-3364(p.125-50))
C–Ir, vaporization, 17: 4933 (WADD-TR-60-463(Pt.II))
C–U, oxidation protection of reactor fuel elements using, 17: 5590(P)
**CARBON TETRACHLORIDE**
effects on radioinduced polymerization of butadiene, 17: 4575 (TID-7643(p.109-17))
polarizability of liquid, corrections for zero-field many-body, 17: 4526
**CARBONYLS**
force constants of hexa-, from molecular orbitals, 17: 5108
**CARCINOMAS**
radiotherapy of bladder, effectiveness of, 17: 4385
**CAROLINAS-VIRGINIA TUBE REACTOR**
description, 17: 5617
description and performance of, 17: 5612
development of, in April to June 1962, 17: 5606(R) (CVNA-156)
safety of, analysis of loss-of-coolant accident in, 17: 5618
**CASTING**
research program, 17: 4910(R) (MAB-139-M(C7))
**CATHODE-RAY TUBES**
reversed-biased p-n junctions in, 17: 4787
**CATHODES**
development of materials for thermionic cell, 17: 5577 (GA-3523)
removal of beryllium deposits from, 17: 4656(P)
theory of thermionic hollow, zero-field emission, 17: 5083
**CATTLE**
radiation effects on synthesis of proteins and RNA in thyroid gland of, 17: 4397
**CAVITY RESONATORS**
electromagnetic wave-plasma interactions in, 17: 5500
**CELLULOSE**
radiation chemistry, 17: 4588 (TID-7643(p.319-34))
radiation effects on apparent energy and entropy of activation of cotton, gamma, 17: 5021
radioinduced graft polymerization, 17: 4588 (TID-7643(p.319-34))
radioinduced grafting of monomers to, 17: 4585 (TID-7643(p.259-67))
**CEMENTS**
development of, for nuclear technological uses, 17: 4973
**CERAMIC COATINGS**
radiation effects on, 17: 4990 (HW-SA-2814)
**CERAMIC MATERIALS**
brazing graphite and oxide, 17: 4912(R) (ORNL-TM-413)
development of, for nuclear technological uses, 17: 4973
radiation effects on, 17: 4990 (HW-SA-2814)
thermal analysis of, design of equipment for, 17: 5041(R) (ORNL-3364 (p.151-200))
thermal conductivity at high temperatures, measurement of, 17: 4774(T) (EURAEC-415)
**CERIUM**
effects on flash mechanism in phosphors, 17: 5049(T) (UCRL-Trans-853(L))
movement in ground water at Savannah River Plant, 17: 4700
separation by electrophoresis on zirconium phosphate paper, 17: 4467
separation from plutonium by anion exchange, quantitative, 17: 4629
viscosity, 17: 4375(R) (MLM-1133)
**CERIUM ALLOYS**
corrosion of, bibliography on, 17: 4904 (LAMS-2779)
Ce–Co–Pu, density and viscosity of, 17: 4944
Ce–Fe, chemical properties and structure of pyrophorous, 17: 4935(T) (AEC-tr-5545)
Ce–Pu, phase diagram, 17: 4984
Ce–Pu, phase studies, 17: 4374(R) (MLM-1129)
Ce–Pu, phase studies, 17: 4375(R) (MLM-1133)
**CERIUM CHLORIDES**
$CeCl_3$–KCl, composition and thermodynamic functions of vapor phase, 17: 5284
**CERIUM COMPLEXES**
with semicarbazide hydrochloride, thiourea, and urea, formation,

17: 4544

**CERIUM COMPOUNDS**
preparation and properties of hydrocarbon-soluble organic, 17: 4450

**CERIUM IONS**
oxidation potential of ceric–cerous electrode in sulfuric acid, 17: 4539

**CERIUM ISOTOPES Ce-144**
efficiency as electrogenerator power source, 17: 5645

**CERIUM OXALATES**
decomposition of hydrate, 17: 4543

**CERIUM SYSTEMS**
Ce–Se, phase diagrams, 17: 4886(R) (AD-275610)

**CERMETS**
thermal capacity at 30 to 800°C, 17: 4523

**CESIUM**
cesium ion mobilities in, 17: 5136
electron and ion collision cross sections with, 17: 5136
movement in ground water at Savannah River Plant, 17: 4700
separation by electrophoresis on zirconium phosphate paper, 17: 4467
separation from Purex Process wastes by solvent extraction, 17: 4625 (HW-SA-2767)
sorption from tungsten, field, 17: 4525
vapor pressure, 17: 4947
viscosity of, relation of atomic mobility to, 17: 4945

**CESIUM CHLORIDES**
self-diffusion of ions in liquid, coefficients of, 17: 4513

**CESIUM IODIDE CRYSTALS**
scintillation processes in thallium-activated, 17: 5034 (ORNL-3354)

**CESIUM IONS**
mobilities in gaseous cesium and helium, 17: 5136
neutralization of annular beam, 17: 5647
reactions on metal surfaces, negative-ion yields from, 17: 5087
scattering by molybdenum surfaces, spectra from, 17: 5154(T)
self-diffusion in molten cesium chloride, coefficient of, 17: 4513

**CESIUM ISOTOPES Cs-137**
electron and photon spectra of, below 1 Mev, 17: 4857
internal conversion in, electron spectra from, 17: 4855
uptake and excretion by rat, effects of drugs on, 17: 4391

**CHARGED PARTICLE BEAMS**
acceleration of, shielding requirements in, 17: 5057
intensity of synchrocyclotron, 17: 5418
production of polarized, 17: 5076

**CHARGED PARTICLES**
acceleration, 17: 5427(P)
effects on geomagnetic field, 17: 4704
focusing of, by homogeneous magnetic field with straight boundary, 17: 5157
gage invariance and the structure of, 17: 5235
interactions in detectors, 17: 4820
interactions of, electrostatic and magnetostatic energy in electromagnetic, 17: 5203 (UCRL-6499)
mirror-point distributions along field lines, 17: 5182
motion in magnetic fields, electron model of, 17: 5424
scattering amplitude in Yukawa potential, 17: 5227
spectra in inner Van Allen belt, 17: 5195
tracks in emulsion, identification of, 17: 5110
velocities in one-dimensional plasma, 17: 5478

**CHEMICAL PROPHYLAXIS**
of radiation sickness in guinea pigs, effects of diphacyl on, 17: 4436

**CHEMICAL RADIATION DETECTORS**
development, 17: 5041(R) (ORNL-3364(p.151-200))
development for monitoring gamma capture in thermal-neutron shielding, 17: 5039(R) (ORNL-3364(p.85-124))
efficiency of ferrous sulfate, for beta particles, 17: 4597

**CHERENKOV DETECTORS**
design of differential DISC, with velocity selection, 17: 4826
performance of liquid differential DISC, 17: 4827

**CHERENKOV RADIATION**
production in extensive air showers, distributions in, 17: 5197

**CHLORELLA**
photosynthesis by, effects of oxygen on formation of glycolic acid in, 17: 4380(R) (UCRL-10479)
spectra of, evaluation of techniques for determining absorption, 17: 4380(R) (UCRL-10479)
sugar phosphates in, effects of dark-light transients, 17: 4561(R) (UCRL-10350)
synthesis of compounds from labeled carbon dioxide by, in dark following preillumination, 17: 4380(R) (UCRL-10479)

**CHLORIDE IONS**
self-diffusion in molten cesium, rubidium, and sodium chlorides, coefficients of, 17: 4513

**CHLORINE ISOTOPES**
helium-3 elastic scattering by, optical model for, 17: 5364

**CHLORINE ISOTOPES Cl-34**
yield in $(\gamma,n)$ reactions in chlorine-35, 17: 5344

**CHLORINE ISOTOPES Cl-35**
gamma reactions $(\gamma,n)$ at 30 Mev, cross sections of, 17: 5344
nuclear magnetic resonance of, in ferrous chloride, 17: 4537

**CHLOROFORM**
effects on radioinduced polymerization of butadiene, 17: 4575 (TID-7643(p.109-17))

**CHLOROPLASTS**
lipophilic quinone occurrences in, 17: 4380(R) (UCRL-10479)
phosphatase activity in, effects of methanol, 17: 4380(R) (UCRL-10479)
photosynthetic phosphorylation by spinach, effects of sonication on, 17: 4380(R) (UCRL-10479)
preparation and characterization of complexes of, 17: 4561(R) (UCRL-10350)

**CHROMATOGRAPHY**
development of reversed phase, for various cations, 17: 4445 (IS-500 (Sect.C))

**CHROMIUM**
alloying effects on aluminum–niobium–titanium alloy oxidation, 17: 4903(R) (DRI-2075)
determination by fast neutron activation, 17: 4479
mechanical properties of, effects of nitrogen on, 17: 4447 (IS-500 (Sect.M))
preparation of high-purity, 17: 4447 (IS-500(Sect.M))
separation from plutonium by anion exchange, quantitative, 17: 4629

**CHROMIUM ALLOYS**
tensile properties of various binary, 17: 4447 (IS-500(Sect.M))
Cr–Ni, neutron radiation effects on stress-rupture strength of A-286, 17: 4992
Cr–Ni–Nb, phase diagram, 17: 4978
Cr–U, electric conductivity of, 17: 4446 (IS-500(Sect.E))

**CHROMIUM ISOTOPES Cr-51**
effects on viability of ascitic tumor cells, 17: 4410
production in thick iron targets by protons at 3 Bev, 17: 5336

**CHROMIUM NITRATES**
thermal decomposition of nonahydrate of, 17: 4492 (IDO-14597)

**CHROMIUM OXIDES**
additive effects on gamma-induced thermoluminescence in aluminum oxide crystals, 17: 4997
radiation effects on catalytic action in thermal dissociation of ethanol, 17: 4569 (NP-12250)

**CHROMIUM STEEL**
corrosion by bismuth–lead eutectic, 17: 4906
rupture strength of molybdenum, in helium at 1000 and 1200°F, 17: 4980

**CHROMOSOMES**
survival of lethal genes in *Drosophila melanogaster*, 17: 4434

**CIRCUITS**
couplings for fluid flow, 17: 4685(P)
design of alternating-magnetic-field generators, 17: 4794
design of triggering, for spark chambers, 17: 4856
development of two-channel regulatory delay-type, for camera shutter operation, 17: 4785
transmission system design for cryogenic, 17: 4788

**CLOUDS**
sampling of, using rockets, 17: 4692 (UCRL-13054)

**COATINGS**
application of silver, on beryllium, 17: 4919(P)
deposition of oxidation-resistant, on refractory metals, 17: 4964

**COBALT**
determination in complex mixtures by x-ray absorption, 17: 4462
phase structure of, structure heredity between $\alpha$ and $\beta$ phases in,

17: 4948
  separation by electrophoresis on zirconium phosphate paper, 17: 4467

**COBALT ALLOYS**
  casting, 17: 4910(R) (MAB-139-M(C7))
  corrosion of, bibliography on, 17: 4904 (LAMS-2779)
  Ce–Co–Pu, density and viscosity of, 17: 4944
  Co–Pu, phase diagram, 17: 4984
  Co–Zr, phase studies, 17: 4447 (IS-500(Sect.M))

**COBALT CHLORIDES**
  gamma angular distribution of manganese-54 oriented in antiferromagnetic hexahydrated, 17: 4509

**COBALT(II) CHLORIDES**
  reactions with graphite, intercalation in, 17: 4552

**COBALT FILMS**
  effects on superconducting transition temperature of tin, 17: 5139

**COBALT ISOTOPES Co-54**
  positron decay, 17: 5325 (PUC-1962-62)

**COBALT ISOTOPES Co-57**
  energy levels of, from nickel-57 decay, 17: 5378

**COBALT OXIDES**
  CoO–$SiO_2$, viscosity, 17: 4933 (WADD-TR-60-463(Pt.II))

**COCKCROFT-WALTON ACCELERATORS**
  calibration of tritium (d,n) helium-4 yield from, 17: 5412 (NDL-TM-6)

**COINCIDENCE MEASUREMENTS**
  analysis of delayed, for determinations of nuclear lifetimes, 17: 5354
  techniques for special samples, 17: 4845

**COLD NEUTRONS**
  sources of, status of European, 17: 5296 (EANDC-22L)

**COLLIMATORS**
  performance of aluminum, in focusing 5-Bev electron beam, 17: 5413 (ORNL-TM-423)

**COLLOIDS**
  chemistry of, review of, 17: 4516
  propulsion with, electrostatic system design for, 17: 5645

**COLORADO PLATEAU**
  geology of uranium deposits of, 17: 4714

**COMMUNICATION SYSTEMS**
  decametric wavelength absorption resulting from thermonuclear explosion, 17: 5116

**COMPRESSORS**
  design of centrifugal, 17: 4639 (ORNL-3294)

**COMPTON EFFECT**
  measurement of internal, 17: 5123

**COMPUTER PROGRAMS**
  CLSO, for decay curve analysis on IBM-7090, 17: 5411
  for calculating atomic displacements by energetic electrons on IBM 7090, 17: 5036(R) (ORNL-3364(p.1-26))
  for computing para-hydrogen properties from pressure and temperature on IBM-7090, 17: 4493 (LAMS-3762)
  SOPHY, reactor design code for IBM-650, 17: 4877 (CNEN-141)

**COMPUTERS**
  programming for analysis of s-wave neutron resonances, 17: 5295 (CEA-2156)

**CONCRETES**
  shielding properties of, in high-energy accelerators, 17: 5057

**CONFERENCES**
  American Power Conference, Chicago, March 1962, 17: 5621
  Conference on Application of Large Radiation Sources in Industry and Especially to Chemical Processes, IAEA, Warsaw, September 8 to 12, 1959, Wien, 1960, review of, 17: 4758
  International Symposium on Radiation-Induced Polymerization and Graft Copolymerization, Battelle Memorial Institute, November 29 and 30, 1962, 17: 4570 (TID-7643)
  Proceedings of International Conference on Ionization of the Air, Philadelphia, Oct. 16 to 17, 1961, 17: 4379
  Radiation Effects in Refractory Fuel Compounds, Atlantic City, N. J., June 1961, 17: 4893
  Recent Developments in the Sterilization of Surgical Materials, London, April 1961, 17: 4760

**CONSTANTS AND CONVERSION FACTORS**
  relation between properties of elementary particles and natural constants, 17: 5215

**CONVECTION (FORCED)**
  film boiling on plate with uniform surface heat flux, 17: 4677
  fluid flow in tubes, with variable viscosity, 17: 4675
  heat transfer in tubes by thermal radiation and, 17: 4671

**CONVECTION (FREE)**
  effects on fluid flow stability in vertical pipes, 17: 4669
  unsteady, near infinite vertical plate, 17: 4672

**COPPER**
  alpha reactions $(\alpha,p)$ at 30 Mev, angular distributions from, 17: 5339
  cesium ion reactions on, negative-ion yields from, 17: 5087
  determination by fast neutron activation, 17: 4479
  dislocation pinning and elastic modulus of electron-irradiated, at 4.2°K, 17: 4996
  dissolution of, anodic, 17: 5038(R) (ORNL-3364(p.57-84))
  electric mobility in bismuth (liquid) at 500°C, 17: 4946
  mesons $(\mu^-)$ capture by, neutrinoless, 17: 5377
  proton scattering by, at 7.5 to 9.75 Mev, 17: 5398
  radiation effects, 17: 5038(R) (ORNL-3364(p.57-84))
  radiation effects on pure, reactor-neutron, 17: 5001
  separation by electrophoresis on zirconium phosphate paper, 17: 4467
  separation from plutonium by anion exchange, quantitative, 17: 4629
  shielding properties of, in high-energy accelerators, 17: 5057
  sputtering of, by argon ions, 17: 5038(R) (ORNL-3364(p.57-84))
  sputtering of, by rare-gas ions, 17: 5036(R) (ORNL-3364(p.1-26))
  viscosity of, relation of atomic mobility to, 17: 4945

**COPPER ALLOYS**
  Al–Cu, radiation effects on atomic rearrangement, 17: 5040(R) (ORNL-3364(p.125-50))
  Be–Cu–Ti, properties as brazing alloy, 17: 4912(R) (ORNL-TM-413)
  Cu–Zr, effects of arsenic on electric conductivity of, 17: 4938

**COPPER CHLORIDES**
  spectra of, rotational structure of emission, 17: 5070

**COPPER COMPLEXES**
  with diethyldithiocarbaminate, precipitation of indium, silver, and thallium with, 17: 4475

**COPPER CRYSTALS**
  dislocations in, vacancy clustering in, 17: 5038(R) (ORNL-3364(p.57-84))
  internal friction, 17: 5038(R) (ORNL-3364(p.57-84))
  mechanical properties of, effects of annealing and radiation on, 17: 5002
  preparation of low-dislocation-density, 17: 5038(R) (ORNL-3364(p.57-84))
  radiation effects on, neutron, 17: 5024
  sputtering by argon ions at 1 to 5 kev, yields from, 17: 5089

**COPPER FILMS**
  electron inelastic scattering by thin, theory for, 17: 5281(T)

**COPPER ISOTOPES**
  helium-3 elastic scattering by, optical model for, 17: 5364

**COPPER ISOTOPES Cu-58**
  positron decay, 17: 5325 (PUC-1962-62)

**COPPER OXIDE CRYSTALS**
  radiation effects on optical absorption, 17: 5039(R) (ORNL-3364(p.85-124))

**COPPER OXIDE FILMS**
  radiation effects on, on glass, 17: 5020

**COPPER OXIDES**
  radioinduced exciton absorption spectrum of, comparative effects of neutrons and gamma rays on, 17: 4994

**COPPER PERCHLORATES**
  reactions with dioxane, structure of addition compound formed in, 17: 4452

**CORROSION**
  bibliography on, 17: 4904 (LAMS-2779)

**CORTICOSTERONES**
  desoxy-, effects on excretion of cesium-137 by rats, 17: 4391

**CORTISONE**
  excretory effects on cesium-137 in rats, 17: 4391
  protective effects against leukosis in mice exposed to x radiation, 17: 4396

**COSMIC MESONS**
  intensity variations in Canada, 17: 5180

**COSMIC NUCLEONS**

intensity variations in Canada, 17: 5180

**COSMIC PARTICLES**
interface with geomagnetic field, location of, 17: 5454

**COSMIC PROTONS**
contribution to radiation dose in space vehicles, 17: 5646
production of Martian blue haze by solar, 17: 5168
reactions in lead of Discoverer 17 satellite by solar-flare, 17: 5098
trajectories in the geomagnetic field, 17: 5179 (AFCRL-62-453)

**COSMIC RADIATION**
abundance of deuterons and tritons in primary, 17: 5189
abundances and energies of hydrogen, helium, and heavy nuclei in, in the Nov. 12, 1960, solar flare, 17: 5193
anisotropy direction, 17: 5196
detection and measurement at 125,000 ft altitude, 17: 5163 (ARL-TDR-62-2)
detection in space with nuclear emulsion, 17: 5194
distribution in geomagnetic field, spatial, 17: 5192
increase on July 20, 1961, 17: 5181
intensity oscillations in, phase anticipation in diurnal, 17: 5188
interaction with solar flare plasma, 17: 5187
interface between solar wind and geomagnetic field, stability of, 17: 5173
interface between solar wind and geomagnetic field, 17: 5174
measurement, 17: 4717
photon density and gamma-ray flux at a point in an expanding universe, 17: 5177
production of isotopes in meteorites by, review of, 17: 4693
reactions on meteorites, review of, 17: 5060
threshold rigidities in geomagnetic field, 17: 5190
threshold rigidities in geomagnetic field, 17: 5191

**COSMIC SHOWERS**
Cherenkov radiation from extensive air, distributions of, 17: 5197

**COSMOLOGY**
formation of planets and sun, 17: 5167
model of the universe, pulsating, 17: 5176
photon density and gamma-ray flux at a point in an expanding universe, 17: 5177

**COTTON**
radiation effects on apparent energy and entropy of activation of, gamma, 17: 5021

**CRITICAL ASSEMBLIES**
neutron diffusion in, discrete ordinate quadratures for, 17: 5313
safety review of, at Oak Ridge, 17: 4742 (ORNL-TM-349)

**CRITICALITY STUDIES**
conversion ratios in enriched uranium lattices moderated by water, 17: 5576 (BNL-5985)

**CROSS SECTIONS**
extrema velocities of total elastic, for atomic beam scattering, 17: 5090

**CRYOGENICS**
bibliography on, 17: 5065
electric transmission system design in, for cryotron circuits, 17: 4788
thermometers for use in, description of liquid-helium, 17: 4790

**CRYSTAL STRUCTURE**
phonon absorption in, 17: 5118
phonon radiation for ultrasound extinction in, 17: 4982
quantization of phonon field, 17: 5120

**CRYSTALLOGRAPHY**
analysis of SMAKULA's formula for F-center concentrations, 17: 5032 (BLG-123)

**CRYSTALS**
carrier capture probability in nonmetallic, 17: 5036(R) (ORNL-3364 (p.1-26))
charged-particle detection and tracking in layer-structure, 17: 4998
charged-particle track etching in silicate, 17: 4999
critical simplicities in Brillouin zones, 17: 5036(R) (ORNL-3364 (p.1-26))
exchange potential of, correction to Slater, 17: 5147
lattice parameter determination, 17: 4490 (GAT-T-1052)
neutron diffraction by, review of, 17: 5059
neutron scattering by anharmonic, thermal, 17: 5317
nuclear magnetic relaxation in, near Curie temperature, 17: 5402
nuclear magnetic resonance of nuclei in, line shape analysis by lattice harmonics, 17: 5134
radioinduced defect clusters in, energy required for, 17: 5039(R) (ORNL-3364(p.85-124))
structure of, gamma angular distribution measurements, 17: 5069

**CYANOGEN**
cyanogen–cyclohexane systems, radiolysis of, determination of gas yields in, 17: 4593(R) (TID-17266)

**CYCLOHEPTATRIÈNE**
electron spin resonance of electron irradiated, 17: 4604

**CYCLOHEXANE**
cyanogen–cyclohexane systems, radiolysis of, determination of gas yields in, 17: 4593(R) (TID-17266)
positron annihilation in solid, as function of temperature, 17: 4567

**CYCLOHEXANOL**
solvent properties for thorium in thiocyanate, 17: 4631

**CYCLOPENTADIENE**
radioinduced polymerization of, effects of ammonia on, 17: 4576 (TID-7643(p.118-26))

**CYCLOTRON RADIATION**
emission by plasma, collective effects on, 17: 5503

**CYCLOTRONS**
dee voltage stabilizer for variable energy, 17: 5417
target assembly design for recoil collection by gas entrainment, 17: 5422

**CYLINDERS**
neutron multiplication factors for bare, 17: 5198 (HASL-124)

**CYRTOLITES**
analysis of natural, for impurities, 17: 4716

**CYSTEINE**
protective effects against radiation injuries in rats, 17: 4437

## D

**DECAY CURVES**
analysis of, computer program for, 17: 5411

**DENSITOMETERS**
sensitivity of gas, using electron scattering, 17: 4777

**DENSITY**
matrix of large systems, evolution of, 17: 5114
matrix representations, 17: 5051

**DEUTERIUM**
abstraction of hydrogen by, in isobutane and propane, 17: 4562
determination in hydrogen-containing compounds, quantitative, 17: 4488(P)
exchange with hydrogen on irradiated silica gel, 17: 5026
isotope effect in Diels-Alder reaction of maleic anhydride with 2-methylfuran, 17: 4568
plasma of, electric-thermonuclear power balance in, 17: 5515
separation from hydrogen and tritium by gas chromatography, 17: 4875

**DEUTERON BEAMS**
production of polarized, 17: 5076

**DEUTERONS**
electric polarizability of, 17: 5242
electrodisintegration of, rescattering correction to, 17: 5232
form factors of, dispersion theory of, 17: 5237
interactions with electrons, elastic, 17: 5237
reactions (d,$\alpha$) with lithium-6 at 0 to 5 Mev, 17: 5322 (NP-12258)
reactions (d,$\alpha$) and (d,p) on oxygen-16, spectra from, 17: 5367
reactions (d,n) with tritium in Cockcroft-Walton Accelerator, alpha and neutron yields from, 17: 5412 (NDL-TM-6)
scattering by nuclei, effect of the nuclear electric field on elastic, 17: 5384
stripping reactions of, spin-orbit distortion in, 17: 5375
tracks in emulsion, identification of, 17: 5110

**DIAMONDS**
synthesis of, carbon isotope effect in, 17: 4511

**DICHROMATES**
neutron capture by, chromium in, chemistry of, 17: 4595

**DIDO REACTORS**
uses in development of British nuclear power program, 17: 5636

**DIELECTRICS**
cross-linking of, in electric capacitors, 17: 4798(P)

**DIES**
development of, for refractory metal extrusion, 17: 4911(R) (NMI-9700.3)

**DIFFUSION**
coefficient of, tracer technique for measurement of, 17: 4549
**DIOXANE COMPLEXES**
with bivalent metal perchlorates, formation and structure, 17: 4452
**DODECYLAMINES**
solvent properties of tri-, for nitric acid, 17: 4453
**DOGS**
kidney angiography in, using colloidal thorium dioxide, 17: 4382
radiation effects on, role of autoinfection in lethal whole-body, 17: 4433
radiation injuries in, protective effects of AET against, 17: 4440
radiation sickness in, therapy of, 17: 4439
radiosensitivity of blood cells in, 17: 4405
**DRESDEN POWER REACTOR**
description, 17: 5611
operation and performance of, symposium on, 17: 5626
**DROSOPHILA**
radioinduced lethal genes in, survival of, 17: 4434
**DRUGS**
excretory effects on cesium-137 in rats, 17: 4391
protective effects against strontium-90 radiation effects in rats, 17: 4438
**DRYING APPARATUS**
performance of, for processing raffinate from uranyl nitrate extraction, 17: 4630
**DUAL-TEMPERATURE PROCESS**
control of, 17: 4873
**DYSPROSIUM**
Fermi surface of, 17: 5401
separation by electrophoresis on zirconium phosphate paper, 17: 4467
**DYSPROSIUM ALLOYS**
Dy–Zr, surface tension of liquid, 17: 4943
**DYSPROSIUM FERRATES(III)**
hyperfine interactions of 2+ rotational state of dysprosium-160 in, 17: 5031 (AFOSR-2535)
**DYSPROSIUM ISOTOPES Dy-160**
hyperfine interactions in 2+ state of, in iron garnets at 94°K, 17: 5031 (AFOSR-2535)
**DYSPROSIUM ISOTOPES Dy-165**
conversion electron spectrum, 17: 4812

## E

**EARTH**
age estimation using fission processes, 17: 4707
formation of, interval between nucleosynthesis and, 17: 5172
**EARTHQUAKES**
focal mechanism of, 17: 4703
seismic data at Hebgen Lake, Montana, Feb. 25, 1962, 17: 4691 (NP-12286)
**ELECTRIC ARCS**
decay mechanism of fireball phenomena, 17: 5455
**ELECTRIC CONDENSERS**
characteristics of components of energy storage banks, 17: 4645
discharge of high-energy, switch for rapid, 17: 4782
production of, having irradiated dielectric material, 17: 4798(P)
**ELECTRIC CONDUCTIVITY**
measurement of, using a magnetic probe, 17: 4786
of turbulent plasma, 17: 5472
transport equation for, in inhomogeneous fields, 17: 5151
**ELECTRIC CONTROL SYSTEMS**
automatic sample changer for boiling-down procedure, 17: 4783
**ELECTRIC DISCHARGE**
concentration of electrode material in plasma of, 17: 5465(T)
development of canal, in gases, 17: 5158
magnetic field effects on plasma in, 17: 5460
production of high intensity current in filiform, emitted by fine point, 17: 5450
sheath formation, theory, 17: 5508
stability of a collisionless plane, electrostatic, 17: 5464
**ELECTRIC FIELDS**
conductivity in inhomogeneous, 17: 5151
**ELECTRIC GENERATORS**
description of triode systems for direct, using fission-fragment energy, 17: 5068
**ELECTRIC POWER**
conference on generation, utilization, and transmission, 17: 5621
generation of, magnetohydrodynamic plant design for, 17: 5629
generation of, working fluids for, 17: 5628
**ELECTRIC PROPERTIES**
electrodynamic field equations for magneto-electric media, 17: 5126
**ELECTRODES**
distribution of material in arc plasma, 17: 5465(T)
operation of gaseous diffusion fuel-cell, rate limiting steps in, 17: 4886(R) (AD-275610)
oxidation potential of ceric–cerous, in sulfuric acid, 17: 4539
**ELECTRODYNAMICS**
field equations for magneto-electric media in, 17: 5126
**ELECTROLYTIC CELLS**
beryllium deposit removal from base of, 17: 4655(P)
beryllium deposit removal from cathodes of, 17: 4656(P)
**ELECTROLYTIC SEPARATION PROCESSES**
for natural isotopes, review of, 17: 4874
**ELECTROMAGNETIC FIELDS**
charged-particle interactions in, electrostatic and magnetostatic energy of, 17: 5203 (UCRL-6499)
energy-momentum tensor in gravitational field, uniqueness, 17: 5537
gas relaxation and transport in, 17: 5531 (AFCRL-62-281)
in two moving media, boundary conditions, 17: 5535
interaction of two-level system with stochastic, 17: 5052
interactions with ionized gases, analysis of, 17: 5429 (AD-275288)
**ELECTROMAGNETIC PUMPS**
operation and performance of, for metals (liquid), 17: 4643
**ELECTROMAGNETIC WAVES**
absorption by electron gas, 17: 5458
absorption in ionized gases, equation for, 17: 5207
absorption in partially ionized plasma, negative, 17: 5481
decametric wavelength absorption resulting from thermonuclear explosion, 17: 5116
from nuclear explosions, effects of geomagnetic field on, 17: 5099
interactions with plasma, 17: 5431 (AFCRL-62-185)
interactions with cold plasma, 17: 5500
interactions with plasma, theory for nonlinear, 17: 5506
propagation in random media, 17: 5541
propagation of amplitude-modulated, in a plasma, 17: 5509
reflection from moving plasma in semiconductor, 17: 5513
statistical parameters after passage through plasma, 17: 5445
velocity in plasma, group, 17: 5444
**ELECTROMAGNETISM**
conformal invariance in, 17: 5572
solution of Maxwell's equations for magneto-ionic media with sources, 17: 5530 (AFCRL-62-247)
**ELECTRON BEAMS**
acceleration and control in betatrons, 17: 5414
collimation of 5-Bev, evaluation of aluminum collimator for, 17: 5413 (ORNL-TM-423)
dosimetry, 17: 4749
energy distribution across potential drop, 17: 5452
motion in magnetic fields, 17: 5191
power density in optimally focused space-charge-limited, 17: 5086
use in brazing and welding, 17: 4921(P)
**ELECTRON-DIFFRACTION ANALYSIS**
precision of measurements in, 17: 4458 (GAT-T-1050)
**ELECTRON MULTIPLIER TUBES**
design of continuous-dynode, 17: 4792
**ELECTRON SCATTERING CROSS SECTIONS**
elastic, Regge behavior of, 17: 5263
**ELECTRON TUBES**
performance of 90° flat-plate magnetic triode for direct energy conversion, 17: 5640 (NASA-TN-D-1532)
reversed-biased p-n junctions in, 17: 4787
**ELECTRONIC EQUIPMENT**
design of alternating-magnetic-field generators, 17: 4794
design of triggering systems for spark chambers, 17: 4856
transmission system design for driving cryotron circuits, 17: 4788

**ELECTRONS**
bremsstrahlung from, entering the lower ionosphere, 17: 5092
collision cross sections with cesium atoms, 17: 5136
concentration in the F region, 17: 5102
conductivity in ionized gases, 17: 5072
density in interplanetary space, 17: 5165
density in ionosphere, plasma frequency measurement of, 17: 5078
density in transient plasmas, measurement of, 17: 5432 (AWRE-O-14/62)
density variations in inner Van Allen zone, 17: 5186
diffusion in gases, 17: 5241
diffusion in multimode cavities, 17: 5042 (RADC-TDR-62-67)
diffusion in plasma, effects of microinstabilities on, 17: 5496
distribution in plasma, effects of diffusion on, 17: 5437 (GCA-TR-62-8-A)
distribution in plasma, methods of measurement of, 17: 5439 (PIBMRI-987-62)
dosimetry of, design of extrapolation-ionization chamber for, 17: 4858
emission in solar flare, 17: 5091
emission of secondary, from satellite surfaces, 17: 5644 (ZPh-084)
energy spectrum in mesons ($K^+_{e3}$) decay, 17: 5275
flux of energetic, produced by high-altitude nuclear explosion of July 9, 1962, 17: 5115
general relativistic approach to the Poincaré compensating stresses for classical point, 17: 5551
intensity in outer radiation zone, 17: 5183
interactions in detectors, 17: 4820
interactions with electrons and ions in magnetic fields, 17: 5499
interactions with deuterons, elastic, 17: 5237
interactions with protons, 17: 5239
ionization of nitrogen by, cross sections for, 17: 5142
properties of, for sterilization of surgical materials, 17: 4762
reactions with neon atoms, measurement of metastable atomic parameters in, 17: 5046 (UCRL-10477)
reactions with solids, computer program for calculating atomic displacements in, 17: 5036(R) (ORNL-3364(p.1-26))
relativistic equation for hyperfine structure of S½, 17: 5050
scattering by hydrogen, application of multichannel effective range theory to, 17: 5150
scattering by hydrogen atoms at low energies, 17: 5278
scattering by impurity ions in matter, anisotropy from, 17: 5282(T)
scattering by nuclei through 180°, nuclear excitation by, 17: 5388
scattering by thin films, theory for inelastic single, 17: 5281(T)
scattering in conductors, transport equation for, 17: 5151
scattering of, Boltzmann transport equation for, 17: 5539
scattering of, use in gas density gages, 17: 4777
transport coefficients of quantum plasma, 17: 5510
tunneling between normal and superconducting metals, 17: 5138
yield in irradiated aqueous solutions, effects of organic scavengers on, 17: 4602
**ELECTROSTATIC FIELDS**
plasma kinetics in weak, 17: 5446
**ELECTROSTATIC GENERATORS**
design of, for spacecraft propulsion, 17: 5645
**ELEMENTARY PARTICLES**
anomalous thresholds in unitary theories, 17: 5562
collective treatment of many-body systems, 17: 5566
decay modes of, empirical regularity of weak, 17: 5234
density of systems with an harmonic potential, power series expansion of, 17: 5267
equations for, with two mass states, 17: 5213
gage invariance and the structure of charged, 17: 5235
hypothetical M meson and generalization of the Pomeranchuk relations, 17: 5250
interactions at high energies, multiple production model for, 17: 5399
interactions at high energies, elastic amplitudes for, 17: 5217
interactions of, analyticity and unitarity of general transition amplitudes for, 17: 5547
interactions of, analytic continuation of the S-matrix in angular momentum, 17: 5552
interactions of, coupling constants and unsubtracted dispersion relations for, 17: 5560
interactions of, high energy cross sections for strong, 17: 5225
interactions of, in fixed-fermion field theory, 17: 5210
interactions of, irreducible representations in, 17: 5545
interactions of, partial wave amplitudes in, 17: 5548
interactions of, rearrangement collisions and uniqueness in, 17: 5204 (UCRL-6558-T)
interactions of, S-matrix theory of, 17: 5570
interactions of, similarities of weak, strong, and electromagnetic, 17: 5238
interactions of, symmetries of weak, 17: 5229
interactions with strange particles, review of strong, 17: 5054
kinematics of, at high energies, 17: 5277
macroscopic motion of classical spinning, 17: 5240
magnetic moment of a Lee particle, 17: 5249
physics of, interrelations with nuclear structure, 17: 5395
production of jets of, based on the fireball model, 17: 5231
properties of, relation to values of the natural constants, 17: 5215
properties of the matrix $\beta_s$ relative to the theory of, with spin 1, 17: 5265
Regge-pole hypothesis for, accuracy of, 17: 5258
removal of ghost states in the Lee model, 17: 5556
renormalization of state vectors of, mathematics of, 17: 5269
scattering amplitudes and phase-shifts for, 17: 5228
scattering amplitudes for, Regge pole and Landau singularities in, 17: 5264
scattering of, baryon number conservation in, 17: 5270
scattering of spinless, high Born approximations for Coulomb, 17: 5558
scattering of, triangle inequalities for spin effects in, 17: 5544
structure of, 17: 5209
symmetry principles of, 17: 5280
thermodynamics of isolated, 17: 5212
transformation properties in quantum field theory, derivation of symmetry properties from, 17: 5283
transformations of relativistic, 17: 5208
vacuum states in quantum field theory, 17: 5218
vector field equations for, 17: 5226
**EQUIPMENT AND PROCEDURES**
coupling devices, 17: 4653(P)
**ERBIUM**
Fermi surface of, 17: 5401
separation by electrophoresis on zirconium phosphate paper, 17: 4467
**ERBIUM ALLOYS**
Er–Zr, surface tension of liquid, 17: 4943
**ERBIUM IONS**
reduction mechanisms of alcoholic lithium chloride solutions of trivalent, polarographic studies of, 17: 4507
**ERYTHROCYTES**
radiation effects on blood of, 17: 4402
radiation effects on sodium transport across cell membranes, 17: 4412
**ETHANE**
formation in rare gas sensitized radiolysis of labeled propane, 17: 4601
spectra of hexadeuterated, Raman, 17: 5073
**ETHANE, BROMO-**
luminescence quenching effects on scintillator solutions in benzene and cyclohexane, 17: 4563
**ETHANETHIOL, 2-AMINO-**
protective effects against radiation injuries in rats, 17: 4437
**ETHANOL**
chemical effects on radioinduced reactions of methylene blue, 17: 4592 (TID-14927)
thermal dissociation of, radiation effects on catalysts in, 17: 4569 (NP-12250)
**ETHYL ACETATE**
solvent properties for thorium in thiocyanate, 17: 4631
**ETHYL ETHER**
solvent properties for lithium borohydride and hydride, 17: 4517
**ETHYLENE**
diffusion of krypton-85 in, 17: 4524
formation in rare gas sensitized radiolysis of labeled propane, 17: 4601
radioinduced polymerization of, rates and yields for, 17: 4574 (TID-7643(p.70-106))
radioinduced polymerization with tetrafluoroethylene, radical mechanism of, 17: 4611

$C_5H_5N$–$C_2H_4$, radioinduced polymerization of, 17: 4612
**ETHYLENE, CHLORO-**
radioinduced graft copolymerization of, 17: 4619(P)
**ETHYLENE, CHLORO- POLYMERS**
radioinduced graft polymerization with styrene, effects of methanol on, 17: 4583 (TID-7643(p.233-44))
**ETHYLENE OXIDE**
$C_5H_5N$–$C_2H_4O$, radioinduced polymerization of, 17: 4613
**ETHYLENE POLYMERS**
free-radical decay in irradiated, electron spin resonance studies of, 17: 4581 (TID-7643(p.200-18))
radioinduced crosslinking of, effects of polyfunctional monomers on, 17: 4584 (TID-7643(p.245-58))
radioinduced graft polymerization with t-butylaminoethyl methacrylate, effects of hexane on, 17: 4583 (TID-7643(p.233-44))
radioinduced graft polymerization with acrylic acid, 17: 4591 (TID-7643(p.398-413))
radioinduced graft polymerization with acrylonitrile in vacuum, effects of pre-irradiation on, 17: 4607
radioinduced graft polymerization with methacrylic acid in benzene and and methanol solutions, 17: 4608
radioinduced graft polymerization with methyl acrylate styrene, effects of methanol on, 17: 4583 (TID-7643(p.233-44))
**ETHYLENE, TETRAFLUORO-**
radioinduced polymerization with ethylene, radical mechanism of, 17: 4611
**ETHYLENE, TETRAFLUORO- POLYMERS**
radioinduced graft polymerization with methyl acrylate, 17: 4583 (TID-7643(p.233-44))
**EUROPIUM**
effects on flash mechanism in phosphors, 17: 5049(T) (UCRL-Trans-853(L))
enthalpy and related thermodynamic properties at 0 to 1100°C, 17: 4929 (IS-327)
separation by electrophoresis on zirconium phosphate paper, 17: 4467
spectra in barium, calcium, and strontium fluorides, absorption and luminescence, 17: 4547(T)
**EXPERIMENTAL GAS COOLED REACTOR**
fuel costs, comparison with AGR, 17: 5616
**EXPLODING WIRE PHENOMENA**
microwave interaction with exploding wires, 17: 5480
**EXPONENTIAL PILES**
neutron flux decay in, 17: 5305
**EYES**
radiation protection of lens of, effects of cellular therapy, dehydration, and sulfhydryls on, 17: 4441

## F

**FALLOUT**
analysis for specific fission products, 17: 4746
monitoring in Pacific Islands, 17: 4690(R) (DXRL-F5)
sampling in clouds, 17: 4692 (UCRL-13054)
transport from stratosphere to troposphere, 17: 4699
**FAST NEUTRONS**
detection and measurement of, ionization chamber design for, 17: 4846
scattering by sulfur-32 at 4.6 Mev, angular distribution in elastic and inelastic, 17: 5327
**FERMIONS**
interactions of, solution of Thirring model for, 17: 5546
theory of, quantization of two-component, 17: 5290
**FERMIUM ISOTOPES Fm-254**
energies and intensities of E2 transitions of, 17: 5330
**FERROMAGNETIC MATERIALS**
magnetic properties of non-ferrous, review, 17: 4966
theory of, with cubic clusters of spins, 17: 5027 (AD-273950)
**FIBRINOGEN**
labeling of human serum, with bromine-82, 17: 4387
**FIELD THEORY**
baryon number conservation in, 17: 5270
Cauchy's problem in general relativity, 17: 5549
consistent operator solution for Thirring model, 17: 5546
discontinuities in, unitarity of, 17: 5543
elementary particle coupling constants in, 17: 5210
elementary particle transformation in quantum, 17: 5283
formulation of renormalizable, for vector mesons, 17: 5211
general formalism of, with persistent one-particle states, 17: 5571
Lee model with two V particles, 17: 5563
magnetic moment of a Lee particle, 17: 5249
model of self-coupled meson, 17: 5230
nucleon-nucleon interaction potentials in, review, 17: 5055
operators of proper homogeneous Lorentz group in, 17: 4879
quantization of phonon field, 17: 5120
quantization of Yang-Mills field, 17: 5160
quantization of 2-component fermion, 17: 5290
quantum, proof of equivalence theorems in, 17: 5534
reduction of operator algebra in vacuum states, 17: 5218
relativistic invariance and tacit uniqueness postulate in, 17: 5121
removal of ghost states in the Lee model, 17: 5556
renormalization in, mathematics of, 17: 5269
scattering amplitudes at high energies in, elastic, 17: 5217
similarities of weak, strong, and electromagnetic interactions, 17: 5238
spectrum of interacting Fermi-fields, calculation of correlation energy from, 17: 5155
wave propagation in random media, 17: 5541
**FIJI ISLANDS**
fallout monitoring, 17: 4690(R) (DXRL-F5)
**FILMS**
electron inelastic scattering by thin, theory for, 17: 5281(T)
preparation of multicomponent, by simultaneous multicomponent sputtering, 17: 4892
**FILTERS**
fire detection in radioactive-air, 17: 4772 (RFP-253)
**FINNED TUBES**
production, 17: 4648
thermal efficiency of coated fins, 17: 4670
**FIRES**
detection in radioactive-air filters, evaluation of systems for, 17: 4772 (RFP-253)
**FISSION PRODUCTS**
beta activity of, from thermal fission of uranium-235, 17: 5407
determination in fall-out, 17: 4746
energy spectrum from thin layers of uranium dioxide, 17: 5085
precipitation of, from reactor coolant gases, 17: 5600(P)
properties of, as nuclear debris from nuclear explosions in the presence of sea water, 17: 4750
recoil tracks in silver chloride crystals, 17: 5082
storage in glass, long-term, 17: 5650
tracks in uranium dioxide films, 17: 4974
**FISSION RECOILS**
detection and tracking of, in layer-structure crystals, 17: 4998
detection and tracking of, in silicate crystals, 17: 4999
reaction mechanisms in thin films, 17: 5017
**FLOWMETERS**
calibration of, for gas chromatographic systems, 17: 4375(R) (MLM-1133)
**FLUID FLOW**
book: *Fluid Mechanics and Magnetohydrodynamics*, 17: 5519
circuits, couplings for, 17: 4685(P)
heat transfer and pressure drop in combined free and forced convection, in vertical tubes, 17: 4673
magnetodynamic, correspondence to dynamics of gas flow, 17: 4678
magnetohydrodynamic stability of vortex, 17: 4661 (ORNL-TM-402)
magnetohydrodynamic, behind strong cylindrical shock waves, 17: 5130
stability in vertical pipes, effects of convection, 17: 4669
unsteady free convection near infinite vertical plate, 17: 4672
**FLUID FLOW (LAMINAR)**
forced convection in tubes, with variable viscosity, 17: 4675
heat transfer in, in tubes under slip-flow conditions, 17: 4676
hydromagnetic properties of incompressible, in annuli, 17: 4682
magnetohydrodynamic, in rectangular channel, 17: 4683
temperature distribution in, in circular tube with internal heat generation, 17: 4665
through porous media, approximate three-point correlation function for, 17: 4679

transverse magnetohydrodynamic, past a semi-infinite plate, 17: 5485

**FLUIDS**
- efficiency of thermodynamic, for power generation, 17: 5628
- gravity waves in perfectly conducting, 17: 5476
- hydromagnetic flow in porous wall annulus, 17: 5467
- interaction of shock wave with field in conducting, 17: 5459
- level control in radioactive solutions in electronic boiling-down, 17: 4783
- stability of step shocks through, hydrodynamic, 17: 5127

**FLUORENE**
- fluorescence quenching in cyclohexane solution of, by oxygen, 17: 4566

**FLUORIDES**
- thermodynamic effects in fused salts, 17: 4496 (TID-17367)

**FLUORINE**
- determination by fast neutron activation, 17: 4479

**FLUORINE ISOTOPES**
- helium-3 elastic scattering by, optical model for, 17: 5364

**FLUORINE ISOTOPES F-17**
- energy levels of, 17: 5349
- energy levels of, 17: 5355
- excited state of, lifetime of first, 17: 5353

**FLUORINE ISOTOPES F-18**
- energy levels of, 17: 5367
- retention by fluorobenzene, p-fluorobenzoic acid, and fluorotoluene solutions, 17: 4603

**FLUORINE ISOTOPES F-19**
- nuclear magnetic resonance in manganese fluoride, 17: 5402

**FLUORINE ISOTOPES F-20**
- half life, 17: 5352

**FLUORSPARS**
- color centers in, absorption spectrum studies, 17: 5094

**FOOD**
- radiosterilization of pork muscle, effects of marbeling on chemical organoleptic, and physical properties of, 17: 4767

**FORMIC ACID**
- oxidation of, mechanisms of electrochemical, 17: 4886(R) (AD-275610)

**FREE RADICALS**
- decay of, in irradiated polyethylene, electron spin resonance studies of, 17: 4581 (TID-7643(p.200-18))

**FRENCHMAN FLAT QUADRANGLE (NEV.)**
- geologic map of, 17: 4719

**FRUCTOSE**
- decomposition of carbon-14-labeled, in storage, 17: 4599

**FUEL CELLS**
- description of triode, with fissionable-material-coated cathodes, 17: 5068

**FURANS**
- reaction of 2-methyl-, with maleic anhydride, deuterium isotope effect in Diels-Alder, 17: 4568

**FURNACES**
- testing for uranium dioxide preparation, 17: 4889(T,R) (EURAEC-322)

**FUSED SALTS**
- electric properties of, 17: 4445 (IS-500(Sect.C))
- thermodynamic properties of, 17: 4496 (TID-17367)

## G

**GADOLINIUM**
- Fermi surface of, 17: 5401
- separation by electrophoresis on zirconium phosphate paper, 17: 4467

**GADOLINIUM ALLOYS**
- Ga–La, phase studies, 17: 4981
- Gd–Y, phase studies, 17: 4981

**GADOLINIUM CHLORIDES**
- Stark levels in, effects of configuration interactions on, 17: 4498 (UCRL-10460)

**GADOLINIUM CRYSTALS**
- magnetostriction of single, 17: 4961
- thermal expansion of single, anomalous, 17: 4962

**GADOLINIUM IONS**
- reduction mechanisms of alcoholic lithium chloride solutions of trivalent, polarographic studies of, 17: 4507

**GADOLINIUM ISOTOPES Gd-153**
- electron capture decay, 17: 5392

**GADOLINIUM SYSTEMS**
- Gd–Se, phase diagrams, 17: 4886(R) (AD-275610)

**GALLIUM**
- electron transport properties of liquid, 17: 4975
- separation from plutonium by anion exchange, quantitative, 17: 4629
- viscosity of, relation of atomic mobility to, 17: 4945

**GAMMA DECAY**
- theory of γ-γ angular correlation in combined magnetic and inhomogeneous electrical fields, 17: 5328
- theory of γ-γ angular correlation in combined magnetic and inhomogeneous electrical fields, interaction operator for, 17: 5329

**GAMMA RADIATION**
- angular correlation of, multichannel analyzers for, 17: 4843
- angular distribution of, from oriented nuclei, 17: 5069
- detection and measurement of, ionization chamber design for, 17: 4846
- detection equipment, 17: 4861(P)
- detection in boreholes using a scintillation counter, 17: 4863(P)
- effects in mice and rats, dose-rate dependence of early, 17: 4421
- effects on dogs, role of autoinfection in lethal whole-body, 17: 4433
- effects on protein and RNA synthesis in calf thyroid, 17: 4397
- emission by nuclei, analysis by delayed-coincidence methods, 17: 5354
- flux in interplanetary space, measurement with Ranger 3, 17: 5185
- formation of hydrogen in silica gel by, 17: 4615(T)
- interactions in detectors, 17: 4820
- logging of, in boreholes, 17: 4865(P)
- Mossbauer effect and resonance fluorescence, 17: 5404
- production by neutron capture in nuclei, review of, 17: 5058
- reactions (γ,tn), excitation functions for, 17: 5347
- reactions with aluminum at 24 Mev, proton spectra of, 17: 5340
- reactions with aluminum-27 at 12.5 to 24 Mev, cross sections of, 17: 5341
- reactions with phosphorus-31 and sulfur-32 to 24 Mev, cross sections of, 17: 5342
- reactions with sodium at 2 to 10 Mev, cross sections of, 17: 5343

**GAMMA SPECTRA**
- analysis of pulse height distributions, matrix method, 17: 4831

**GAMMA SPECTROMETERS**
- design of total-absorption scintillation, 17: 4854
- performance of integral-bias sum-peak coincidence, 17: 4828
- performance of lithium-drifted semiconductor, for energies below 100 kev, 17: 4857

**GAMMA SPECTROSCOPY**
- coincidence, using integral-bias sum-peak spectrometer, 17: 4828

**GAS CENTRIFUGES**
- design, 17: 4876(P)

**GAS COOLED REACTORS**
- design and development of high-temperature, 17: 5623
- graphite dimensional changes in, 17: 5008
- heat transfer from spiral-finned polyzonal fuel elements in, 17: 4667
- lubricants for, development and properties of, 17: 4957

**GAS FLOW**
- correspondence to fluid magnetodynamic flow, 17: 4678

**GAS FLOW (LAMINAR)**
- in plasma, Poiseuille, 17: 5494

**GASEOUS FUEL REACTORS**
- design of Soviet, using uranium hexafluoride, 17: 5580 (NP-12239)

**GASES**
- adsorption, book on physical, 17: 5159
- analysis for small amounts of elements, spectrographic, 17: 4487(P)
- beta ray measurement in, review, 17: 4817
- book: *Physical Adsorption of Gases*, 17: 5159
- density matrix of quantum, 17: 5114
- dielectric breakdown in, effects of homogeneous and static field conditions on, 17: 5158
- electromagnetic absorption by ionized, equation for, 17: 5207
- electron diffusion in, 17: 5241
- energy exchange between Maxwellian, at different temperatures, 17: 5128
- heat transfer calculations for rarefied, use of Monte Carlo method in, 17: 4680
- interaction of ionized, with magnetic fields, 17: 5429 (AD-275288)

ionization by pressure at relatively low pressure, 17: 5456
magnetogasdynamic moment equations for, 17: 5129
mechanics of irreversible processes in, 17: 5075
radiation dosimetry in, equivalent to bone and muscle, 17: 4850
relaxation and transport of ionized, in electromagnetic fields, 17: 5531 (AFCRL-62-281)
separation of, design of centrifuge for, 17: 4876(P)
theory of irreversible processes in, 17: 5074
transport coefficients of quantum plasma, 17: 5510

**GASKETS**
sealing of, to pressure vessel openings, 17: 4654(P)

**GEIGER-MUELLER TUBES**
calibration of sensitive volume of, 17: 4842
design of thin-walled cylindrical, for low-energy beta particles, 17: 4823

**GENERATORS**
efficiency of Carnot-cycle magnetoplasmadynamic, 17: 5088

**GENETICS**
radiation effects on reproduction in *Tribolium castaneum* Herbst, 17: 4417
radioinduced lethal genes in *Drosophila melanogaster*, survival of, 17: 4434

**GEOLOGY**
of Colorado Plateau, 17: 4714

**GEOMAGNETIC FIELDS**
auroral zones and SD flow in interplanetary, 17: 5028 (AFCRL-62-423)
cosmic radiation spatial distribution in, 17: 5192
cosmic-ray threshold rigidities in, 17: 5190
cosmic-ray threshold rigidities in, 17: 5191
effect of July 9, 1962, Johnston Island explosion on, 17: 5104
effects of Johnston Island nuclear explosion on, 17: 5103
effects of July 9, 1962, Johnston Island explosion on, 17: 5106
effects of July 9, 1962, Johnston Island explosion on, 17: 5105
effects on electromagnetic signal from nuclear explosion, 17: 5099
interface between solar wind and, stability of, 17: 5173
interface with solar wind, location of, 17: 5454
interface with solar wind, second approximation calculation, 17: 5174
perturbations of, effects of trapped particles on, 17: 4704
polar aurora and electrojet current production in, mechanism involving charge separation for, 17: 5043 (RM-3058-NASA)

**GEOMAGNETIC STORMS**
cosmic noise absorption in sudden commencement of, 17: 5092
effect on outer Van Allen zone, 17: 5184

**GEOPHYSICS**
book: *Advances in Geophysics*, 17: 4703
celestial geodesy, 17: 4703
lateral inhomogeneity in the uppermost part of the earth's mantle, 17: 4703

**GERMANIUM**
radiation effects, 17: 5039(R) (ORNL-3364(p.85-124))

**GERMANIUM COMPOUNDS**
organic, luminescence quenching effects on diphenylanthracene and p-terphenyl in benzene and cyclohexane solutions, 17: 4564

**GERMANIUM CRYSTALS**
sputtering by argon ions at 1 to 5 kev, yields from, 17: 5089

**GERMANY (BAVARIA)**
uranium minerals in northern, age estimation of secondary, 17: 4710

**GLASS**
electric conductivity, 17: 5037(R) (ORNL-3364(p.27-56))
evaluation of cerium-activated, as alpha detector, 17: 4806 (HW-SA-2191)
fabrication of, into spheres of 20 microns, 17: 4375(R) (MLM-1133)
radiation effects on electric conductivity of, 17: 5022
sorptive properties for radioisotopes, 17: 4374(R) (MLM-1129)
thermal decomposition in vacuum systems, 17: 4640 (TID-15465)
use for long-term storage of fission products, 17: 5650

**GLUCOSE**
scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602

**GLUTAMIC ACID**
complexes with uranyl, polarography of, 17: 4538

**GLYCEROL**
scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602

**GLYCOGEN**
radiation effects on metabolism in liver, 17: 4393

**GLYCOLIC ACID**
photosynthesis of, by *Chlorella*, effects of oxygen on, 17: 4380(R) (UCRL-10479)

**GOLD**
alpha reactions $(\alpha,p)$ at 30 Mev, angular distributions from, 17: 5339
cesium ion reactions on, negative-ion yields from, 17: 5087
determination of traces in marine organisms, activation, 17: 4468
radiation damage and recovery in, neutron, 17: 5012
radiation effects on pure, reactor-neutron, 17: 5001
viscosity of, relation of atomic mobility to, 17: 4945

**GOLD FILMS**
electron inelastic scattering by thin, theory for, 17: 5281(T)
particle track production in, by fission fragments, 17: 5017

**GOLD SYSTEMS**
Au–Si, preparation by simultaneous sputtering, 17: 4892

**GONADS**
radiation effects on pregnancies after exposure of, 17: 4423
transplantation of ovaries in radioinduced mouse chimeras, therapeutic effects of, 17: 4432

**GRANITES**
analysis for beryllium, fluorometric, 17: 4698

**GRANODIORITES**
thorium and uranium content in, effects of chemical weathering on, 17: 4697

**GRAPHITE**
brazing to molybdenum, 17: 4912(R) (ORNL-TM-413)
development and properties of, for engineering materials, 17: 4968
development of, for nuclear technological uses, 17: 4973
diffusion of gases from commercial, at 1000 and 1800°C, 17: 4986
electron microscopy of boronated, 17: 4956
electron spin resonance in polycrystalline, 17: 4529
microstructures of recrystallized pyrolytic, 17: 4954
neutron diffusion in, 17: 5293 (BNL-5987)
properties of pyrolytic, 17: 4891
radiation effects on dimensional stability, 17: 4989 (HW-SA-2368)
radiation effects on, 17: 4990 (HW-SA-2814)
radioinduced dimensional changes in reactors, 17: 5008
reactions with cobalt(II) chlorides, intercalation in, 17: 4552
reactions with uranium dioxide, equilibria, 17: 4518
stored energy in reactor moderators of, 17: 5014

**GRAPHITE MODERATED REACTORS**
lubricants for, development and properties of, 17: 4957

**GRAPHITE POWDERS**
thermal conductivity in outgassed, heat transfer in, 17: 4668

**GRASS**
analysis for strontium-90 in Krakow district of Poland, June 1961, 17: 4392

**GRAVITATION**
coupling of graviton to asymmetric and inertial tensor of the Dirac field, 17: 5538
energy-momentum tensor of electromagnetic field in Riemannian space, uniqueness, 17: 5537

**GROUND WATERS**
radionuclides in, at Savannah River Plant, 17: 4700

**GUINEA PIGS**
radiation effects on hematopoietic system in, single, whole-body, 17: 4398
radiation effects on blood of, 17: 4402
radiation injuries in, effects of diphacyl on hemorrhagic syndrome and thrombocytopoiesis in, 17: 4436

## H

**HAFNIUM**
determination, 17: 4633
separation of, from zirconium by anion exchange, 17: 4633

**HAFNIUM ALLOYS**
Hf–Fe, phase transformations in, 17: 4979

**HAFNIUM BROMIDES**
heat of formation and thermodynamic properties, 17: 4501

**HAFNIUM CHLORIDES**
heat of formation and thermodynamic properties, 17: 4501
preparation by sublimation, 17: 4557(P)
**HAFNIUM IODIDES**
heat of formation and thermodynamic properties, 17: 4501
**HAFNIUM IONS**
spectra of doubly ionized, Slater parameters for, 17: 5148
**HAFNIUM ISOTOPES Hf-179**
gamma magnetic transitions in, orbit-flip effects on, 17: 5350
**HAFNIUM OXIDES**
vaporization, 17: 4933 (WADC TR-60-463(Pt.II))
**HALDEN BOILING REACTOR**
operation of, April to June 1962, 17: 5608(R) (HPR-27)
**HALOGENS**
separation of off-gas, scrub tower design for, 17: 5648
**HANDBOOKS AND MANUALS**
radiation safety and control, 17: 4744 (TID-7027)
**HASTELLOY R235**
mechanical properties, effects of combined alternating and static stress, 17: 4965
**HASTELLOY X**
corrosion by potassium, 17: 4905(R) (NP-12334)
**HEALTH PHYSICS**
radiation hygiene in uranium mines, 17: 4747
radiation protection practices in industry, 17: 4751
sanitation rules for personnel handling radioisotopes in USSR, 17: 4752
**HEART**
radiation effects on bacteria infiltration into, in dogs, 17: 4433
**HEAT**
generation in reactors, mathematics of, 17: 5586
**HEAT-RESISTING ALLOYS**
mechanical properties, effects of combined alternating and static stress, 17: 4965
**HEAT TRANSFER**
boundary conditions and time-dependent heat sources, separation-of-variables technique in problems of, 17: 4666
efficiency of coated fins, 17: 4670
forced-convection film boiling on plate with uniform surface heat flux, 17: 4677
from forced-flow water, effects of channel geometry on, 17: 4662(T) (AEC-tr-5538)
from gas-cooled spiral-finned polyzonal fuel elements, 17: 4667
in combined free and forced convection flow in vertical tubes, 17: 4673
in heated tube by combined forced convection and thermal radiation, 17: 4671
in laminar flow in tubes under slip-flow conditions, 17: 4676
in outgassed graphite powders, 17: 4668
in tubes, effects of boiling on, 17: 4663(T) (AEC-tr-5539)
incompressible, effects of nonsteady wall temperature on, 17: 4674
mathematics for, in reactors, 17: 5586
of rarefied gases, calculation using the Monte Carlo method, 17: 4680
to water by convection, effects of vibrations on, 17: 4660(R) (CUA-NE-25)
**HEAVY WATER REACTORS**
description and performance of pressure-tube, 17: 5612
description and prospects of pressurized, 17: 5611
design and technology of, chemical and metallurgical problems in, 17: 4907
physics of, 17: 5585
**HELIUM**
analysis of ionized, mass spectrometric, 17: 4457 (GA-3358)
cesium ion mobilities in, 17: 5136
content of triplet metastable atoms in atmosphere, 17: 5149
diffusion coefficient of helium-3 in liquid, 17: 5122
diffusion of krypton-85 in, 17: 4524
electric discharge in, negative radiation temperature, 17: 5461
electric discharge spectra, 17: 5161
melting curves for helium-3—helium-4 mixtures below 1°K, 17: 5144
phase separation in solid mixtures of helium-3—helium-4, 17: 5145
polarizability of liquid, corrections for zero-field many-body, 17: 4526
radiolysis effects on labeled and unlabeled propane, 17: 4601
reactions with carbon monoxide and nitrogen at high pressure, spectra of, 17: 4527
**HELIUM ION BEAMS (He-3)**
reactions with nuclei (helium-3,p), 17: 5396
**HELIUM ISOTOPES He-3**
concentration in the atmosphere, escape mechanism of, 17: 5095
diffusion coefficient in helium II, 17: 5122
performance of liquid, as low-temperature thermometer, 17: 4790
phase transformation in, anomalous liquid-solid, 17: 5133
production in stars, 17: 5178
properties of liquid and solid, 17: 5065
reactions (He$^3$,αγ) on carbon-13, angular correlations from, 17: 5372
reactions on and scattering by nuclei, optical model for, 17: 5364
reactions on nitrogen-14 and oxygen-16, distributions from, 17: 5363
reactions with medium-weight nuclei, triton production in, 17: 5391
**HELIUM ISOTOPES He-4**
concentration in the atmosphere, escape mechanism of, 17: 5095
performance of liquid, as low-temperature thermometer, 17: 4790
proton reaction processes in, 17: 5178
thermodynamic properties of condensed phases of, 17: 5065
velocity of fourth sound in, measurement at 1.19 to 2.1°K, 17: 5143
**HELIUM ISOTOPES He-5**
energy levels of, 17: 5216
**HELIUM ISOTOPES He-6**
half life, 17: 5352
**HELIUM SYSTEMS**
He—N, analysis of ionized, 17: 4457 (GA-3358)
He—O, analysis of ionized, 17: 4457 (GA-3358)
**HEMATOPOIETIC SYSTEM**
benzene intoxication effects on, 17: 4403
radiation effects on, in guinea pigs, mice, and rats single, whole-body, 17: 4398
radiation effects on, 17: 4403
radiation effects of phosphorus-32 in rabbits on, 17: 4427
radiation effects on rabbit, phosphorus-32 and whole-body, 17: 4428
**HEMOGLOBIN**
radiation effects on, from abdominal skin exposure in rabbits, 17: 4426
**HEMORRHAGE**
syndrome in radiation sickness in guinea pigs, effects of diphacyl on, 17: 4436
**HEPTANE**
effects on radioinduced polymerization of butadiene, 17: 4575 (TID-7643(p.109-17))
**HETEROGENEOUS REACTORS**
loading of, apparatus for, 17: 5604(P)
**HEXANE**
butyl phosphate-hexane, extraction of water into, 17: 4634
effects on radioinduced graft polymerization, 17: 4583 (TID-7643(p.233-44))
**HIGH-ALTITUDE EXPLOSIONS**
detection of nuclear, review of, 17: 5061
energetic particle flux produced by nuclear explosion of July 9, 1962, 17: 5115
geomagnetic field effects of July 9, 1962, Johnston Island shot, 17: 5106
geomagnetic micropulsations from Johnston Island burst, 17: 5103
magnetic disturbance from July 9, 1962, Johnston Island shot, 17: 5104
magnetic effects of July 9, 1962, Johnston Island shot, 17: 5105
**HIGH TEMPERATURE SEPARATION PROCESSES**
research programs on, for fuels, 17: 4445 (IS-500(Sect.C))
**HIROSHIMA**
leukemia incidence in bomb survivors in, 17: 4399
radiation effects on human populations in, 17: 4381
**HOLMIUM**
Fermi surface of, 17: 5401
separation by electrophoresis on zirconium phosphate paper, 17: 4467
**HOLMIUM ALLOYS**
Ho—Zr, surface tension of liquid, 17: 4943
**HOLMIUM IONS**
reduction mechanisms of alcoholic lithium chloride solutions of trivalent, polarographic studies of, 17: 4507
**HOLMIUM ISOTOPES Ho-165**
energy levels, 17: 4812
gamma magnetic transitions in, orbit-flip effects on, 17: 5350

nuclear moments of, effects of intermediate coupling on calculation of, 17: 4528
**HOMOGENEOUS REACTORS**
fuel composition for aqueous, 17: 5605(P)
**HUMBOLDT BAY POWER REACTOR**
description, 17: 5611
**HYDRACRYLIC ACID, β-LACTONE**
radioinduced polymerization of, in solid state, mechanisms of, 17: 4579 (TID-7643(p.150-77))
**HYDRAULICS**
book: *Fluid Mechanics and Magnetohydrodynamics*, 17: 5519
**HYDRIDES**
formation, model, 17: 4541
heats of formation of metallic group IV and V, 17: 4445 (IS-500(Sect.C))
review of solid, 17: 4551
**HYDROBROMIC ACID**
spectra of, vacuum ultraviolet absorption, 17: 4508
**HYDROBROMIC ACID-*d***
spectra of, vacuum ultraviolet absorption, 17: 4508
**HYDROCARBONS**
diffusion from commercial graphite at 1000°C, 17: 4986
pyrolyses of, kinetics and mechanism of carbon deposition during gaseous, 17: 4514
Adakane-12-TBP, polarographic behavior, 17: 4456 (DP-772)
**HYDROCHLORIC ACID**
HCL–$HNO_3$, use for etching charged-particle tracks in silicate crystals, 17: 4999
**HYDRODYNAMICS**
unicity of mass tensor in non-relativistic, 17: 5536
**HYDROFLUORIC ACID**
use for etching charged-particle tracks in silicate crystals, 17: 4999
**HYDROGEN**
abstraction by deuterium in isobutane and propane, kinetics of, 17: 4562
chemical effects on radioinduced reactions of methylene blue, 17: 4592 (TID-14927)
diffusion from commercial graphite at 1000 and 1800°C, 17: 4986
electromagnetic absorption during d-c discharge, equation for, 17: 5208
electron scattering by, application of multichannel effective range theory to, 17: 5150
electron scattering by atomic, at low energies, 17: 5278
exchange with deuterium on irradiated silica gel, 17: 5026
formation in silica gel by gamma irradiation, 17: 4615(T)
light scattering by atomic, cross section for coherent, 17: 5137
positron scattering by atomic, at low energies, 17: 5278
production of neutral beam of, from hydrogen ions, 17: 5117
properties of para-, computer programs for calculating, 17: 4493 (LAMS-2762)
radioinduced agglomeration in beryllium, 17: 4941
separation from deuterium and tritium by gas chromatography, 17: 4875
sorption by zirconium oxides, 17: 4500(T) (AEC-tr-5529)
spectra of solid, line structure in infrared, 17: 5071
yield in irradiated aqueous solutions, effects of organic scavengers on, 17: 4602
yield in radiolysis of labeled and unlabeled biphenyl, effects of liquid-solid phase transition on, 17: 4605
**HYDROGEN COMPOUNDS**
analysis for deuterium, quantitative, 17: 4488(P)
**HYDROGEN ION CONCENTRATION**
effects on radical yields in gamma radiolysis of aqueous systems, 17: 4614
**HYDROGEN IONS**
scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602
splitting of accelerated, neutral hydrogen beam production by, 17: 5117
**HYDROGEN ISOTOPES**
exchange between acids and 1,3-dimethoxybenzene, 17: 4560 (TID-17369)
**HYDROGEN ISOTOPES H-4**
distortion of triton core in hypernucleus, 17: 5332
**HYDROGEN PEROXIDES**
lethal effects on high catalase mutant and wild-type *Rheudopseudomonas spheroides*, 17: 4416
**HYDROGEN SYSTEMS**
H–N, analysis of ionized, 17: 4457 (GA-3358)
H–Pu, phase diagram, 17: 4984
H–Zr, phase studies of, 17: 4939
H–Zr, preparation of crack-free specimens of, 17: 4940
H–Zr, thermophysical properties of, 17: 4940
**HYDROMAGNETIC WAVES**
flows behind cylindrical, 17: 5130
motion of extremely low-frequency, 17: 5433 (D1-82-0150)
structure of collision-free, 17: 5488
**HYDRYLS**
preparation and properties of transition metal, 17: 4925(R) (DRI-2065)
**HYPERFRAGMENTS**
lifetimes of $_{\Lambda}H^{3}$ and $_{\Lambda}H^{4}$, 17: 5292
**HYPERONS**
decay rates of, conserved currents in, 17: 5219
interactions of, review of properties of strong, 17: 5054
interactions with nucleons, mass-difference and strangeness effects in, 17: 5220
interactions with mesons, higher symmetries of, 17: 5224
number conservation in quantum field theory, 17: 5270
properties of new, 17: 5233
**HYPERONS (Λ)**
binding energy in $_{\Lambda}H^{4}$ hypernucleus, 17: 5332
decay of, angular correlation of, 17: 5223
decay of, theory of nonleptonic, 17: 5256
interactions with nucleons, meson (π) contribution to, 17: 5247
properties of, in hyperon ($\Xi^-$) decay, 17: 5261
reactions with nuclei, Coulomb excitation in, 17: 5286
**HYPERONS (Σ)**
decay of, theory of nonleptonic, 17: 5256
**HYPERONS ($\Sigma^0$)**
lifetime, 17: 5286
lifetime of, method for measuring, 17: 5245
**HYPERONS (Ξ)**
decay of, theory of nonleptonic, 17: 5256
effective-mass distribution in meson (π) systems, 17: 5254
**HYPERONS ($\Xi^-$)**
properties of, 17: 5261

## I

**IMMUNITY**
radiation effects on measle, in monkeys, 17: 4401
radiation effects on whole-body, by hypophysis exposure, 17: 4407
**IN-PILE LOOPS**
design, 17: 4991
**INCOMPRESSIBLE FLOW**
hydromagnetic properties of laminar, in annuli, 17: 4682
magnetohydrodynamic, general characteristics of two-dimensional, 17: 5483
transverse magnetohydrodynamic, past a semi-infinite plate, 17: 5485
**INCONEL X**
radiation effects on stress-rupture strength of, neutron, 17: 4992
stress-rupture in-pile testing, 17: 5040(R) (ORNL-3364(p.125-50))
**INDIAN OCEAN**
radiocarbon dating of deep water, 17: 4713
**INDIAN POINT POWER REACTOR**
description, 17: 5611
**INDIUM**
precipitation with copper diethyldithiocarbaminate, 17: 4475
viscosity of, relation of atomic mobility to, 17: 4945
**INDIUM ALLOYS**
In–Pb, structure of liquid, x-ray diffraction studies, 17: 4977
In–Sn, structure of liquid, x-ray diffraction studies, 17: 4977
In–Tl, phase studies, 17: 4447 (IS-500(Sect.M))
Sb–In, sputtering by argon ions at 1 to 5 kev, yields, 17: 5089
**INDIUM CRYSTALS**
thermal expansion of, anisotropic aspects of, 17: 4447 (IS-500(Sect.M))
**INFECTIONS**
radiation effects on measle, in monkeys, 17: 4401
role of auto-, in lethal whole-body irradiation of dogs, 17: 4433
**INFRARED RADIATION**

spectral properties of, from zirconium-arc lamps, 17: 4793

**INFRARED SPECTRA**

of various organic solvents, 17: 4446 (IS-500(Sect.E))

**INFRARED SPECTROSCOPY**

design of zirconium-arc lamp for use in, 17: 4793

**INOR-8**

thermal conductivity at 100 to 800°C, 17: 4942

**INSECTS**

radiation effects on reproduction in *Tribolium castaneum* Herbst, 17: 4417

**INSTRUMENTATION**

accuracy and precision of, 17: · 780

**INSULIN**

labeling of human serum, with bromine-82, 17: 4387

**INTERFEROMETERS**

use of microwave and optical, to measure electron densities in plasma, 17: 5432 (AWRE-O-14/62)

**INTESTINE**

radiation effects on function and structure of villus epithelium in mice, 17: 4420

**IODIDE IONS**

self-diffusion in molten sodium iodide, coefficient of, 17: 4513

**IODIDES**

radioinduced oxidation in alkaline solutions, mechanism, 17: 4598

**IODINE**

abundance in terrestrial crustal rocks, 17: 5172

**IODINE ISOTOPES I-128**

beta activity of, 17: 4825

**IODINE ISOTOPES I-131**

content in animal thyroids and milk in New Zealand, 17: 4690(R) (DXRL-FS)

decay scheme, 17: 5335

transport of, in lakes in Wisconsin, 17: 4715

**IODINE ISOTOPES I-132**

beta decay scheme of, internal conversion effects in, 17: 5371

tracer applications in thyroid physiology, 17: 4386

**ION BEAMS**

acceleration of heavy, review of, 17: 5062

energy distribution across potential drop, 17: 5452

energy spectrum of high-energy, method for measuring, 17: 5419

neutralization of annular, in ion engines, 17: 5647

**ION SOURCES**

description of inverse-magnetron cold-cathode, for cyclotron, 17: 5423

development of heavy-ion, review of, 17: 5062

**IONIZATION**

in air, conference, 17: 4379

**IONIZATION CHAMBERS**

description of portable low-noise, 17: 4846

design of a-c, 17: 4805 (DC-60-2-80)

design of controllable, 17: 4870(P)

design of extrapolation, for measurement of electron and photon radiation, 17: 4858

radiation measurement using, 17: 4866(P)

**IONOSPHERE**

diffusion and drift in F2 regions of, 17: 5029 (AFCRL-62-623)

effects of Sept. 1961 solar flare on, phase observations on, 17: 5101

electron density of, plasma frequency measurements of, 17: 5078

photoionization in the F region, 17: 5102

radiation absorption by, 17: 5469

**IONS**

acceleration of, design of linear accelerator for, 17: 5428(P)

diffusion in plasma, effects of microinstabilities on, 17: 5496

electron scattering by impurity, in solids, 17: 5282(T)

interactions with electrons in magnetic fields, 17: 5499

velocity distribution in plasma, relaxation of, 17: 5457

**IRIDIUM**

vaporization, 17: 4933 (WADD-TR-60-463(Pt.II))

**IRIDIUM ISOTOPES Ir-191**

energy levels of, lifetime of 129-kev, 17: 5408

energy levels of, properties of first-excited, 17: 5408

**IRIDIUM ISOTOPES Ir-193**

energy levels of, properties of first-excited, 17: 5408

**IRIDIUM SYSTEMS**

C–Ir, vaporization, 17: 4933 (WADD-TR-60-463(Pt.II))

**IRON**

analysis of very pure, for impurities by radioactivation, 17: 4480

content and thermonuclear activities in natural terrestrial minerals, 17: 4716

determination by fast neutron activation, 17: 4479

dynamic yield behavior of explosively loaded, 17: 4949

proton spallation at 3 Bev, products from, 17: 5336

radiation effects of neutrons on slip bands in, 17: 5011

separation by electrophoresis on zirconium phosphate paper, 17: 4467

separation from plutonium by anion exchange, 17: 4629

shielding properties of, in high-energy accelerators, 17: 5057

**IRON ALLOYS**

corrosion of, bibliography on, 17: 4904 (LAMS-2779)

Ce–Fe, chemical properties and structure of pyrophorous, 17: 4935(T) (AEC-tr-5545)

Fe–Pu, phase diagram, 17: 4984

Hf-Fe, phase transformations in, 17: 4979

**IRON(II) CHLORIDES**

nuclear magnetic resonance of chlorine-35 in, 17: 4537

**IRON COMPLEXES**

with EDTA, square wave titrimetric end point of, 17: 4486

**IRON COMPOUNDS**

preparation and properties of hydrocarbon-soluble organic, 17: 4450

**IRON CYANIDES**

oxidative effects on square wave titrimetric end point of iron complexes with EDTA, 17: 4486

scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602

**IRON(II) IONS**

radioinduced oxidation in aqueous sulfuric acid solution, mechanism and kinetics of, 17: 4600

**IRON ISOTOPES**

energy levels of, theory of low-lying vibrational, 17: 5365

**IRON ISOTOPES Fe-55**

production in thick iron targets by protons at 3 Bev, 17: 5336

**IRON ISOTOPES Fe-56**

helium nucleus reactions (helium-3,t), spectra from, 17: 5391

**IRON ISOTOPES Fe-57**

isomer shift of, in iron sulfides, 17: 5111

nuclear magnetic resonance in lithium ferrite and magnetite, 17: 5113

**IRON(III) NITRATES**

thermal decomposition of nonahydrate of, 17: 4492 (IDO-14597)

**IRON OXIDE FILMS**

radiation effects on, on glass, 17: 5020

**IRON OXIDES**

$Fe_3O_4$–$FeTiO_3$, magnetic properties, 17: 4959

**IRON(II) SULFATES**

beta dosimetry with, determination of G-values for, 17: 4597

**IRON SULFIDES**

hyperfine structures of iron-57 in, 17: 5111

**IRON SYSTEMS**

C–Fe, stress relaxation, 17: 5040(R) (ORNL-3364(p.125-50))

Fe–N, stress relaxation, 17: 5040(R) (ORNL-3364(p.125-50))

**IRON TITANATES**

$Fe_3O_4$–$FeTiO_3$, magnetic properties, 17: 4959

**IRRADIATION FACILITIES**

design and production of, for commercial uses, 17: 4765

design for production of radioisotopes, 17: 4759

design of tape loop system for transporting and counting samples, 17: 4644

development of low-temperature, 17: 5038(R) (ORNL-3364(p.57-84))

**ISOTOPE EFFECTS**

mechanisms of chemical, 17: 5063

physical chemistry of, 17: 4511

**ISOTOPES**

separation of, by electrolysis, review of, 17: 4874

separation of, by low-temperature distillation, 17: 4374(R) (MLM-1129)

**ISOTOPIC EXCHANGE**

bibliography, 17: 4494 (SCR-512)

**ITALY**

waste disposal facilities, 17: 5649

J

**JACKASS FLATS QUADRANGLE (NEV.)**

geologic map of, 17: 4729

**JANGLE RIDGE QUADRANGLE (NEV.)**

geologic map of, 17: 4734

**JETS**

plasma, temperature measurement by photoelectric pyrometry, 17: 5443 (WADD-TR-60-676(Pt.II))

K

**KETENE**

radioinduced polymerization, 17: 4572 (TID-7643(p.28-55))

radioinduced polymerization of derivatives of, 17: 4572 (TID-7643(p.28-55))

**KETYLS**

spin distribution in radicals of benzophenone, 17: 4535

**KIDNEYS**

angiography of, using colloidal thorium dioxide, 17: 4382

radiation effects on bacteria infiltration into, in dogs, 17: 4433

**KRYPTON**

diffusion of krypton-85 in, 17: 4524

electric discharge in, negative radiation temperature, 17: 5461

polarizability of liquid, corrections for zero-field many-body, 17: 4526

radiolysis effects on labeled and unlabeled propane, 17: 4601

reactions with carbon monoxide and nitrogen at high pressure, spectra of, 17: 4527

reactions with graphitized carbon black, gas-surface, 17: 4534

**KRYPTON ISOTOPES**

helium-3 elastic scattering by, optical model for, 17: 5364

**KRYPTON ISOTOPES Kr-85**

diffusion from uranium dioxide, in-pile, 17: 4896

diffusion in dense gases, 17: 4524

use as gaseous beta source for soft gamma radiography, 17: 4688

**KRYPTON ISOTOPES Kr-87**

diffusion from uranium dioxide, in-pile, 17: 4896

L

**LABORATORIES**

design criteria for, handling radioactive materials in USSR, 17: 4752

**LACTONES**

properties and structure of adono-γ, 17: 4561(R) (UCRL-10350)

**LANTHANUM**

enthalpy and related thermodynamic properties at 0 to 1100°C, 17: 4929 (IS-327)

reactions with benzophenone, spin distribution in, 17: 4535

separation by electrophoresis on zirconium phosphate paper, 17: 4467

**LANTHANUM ACETATES**

polarography of, in anhydrous ethylenediamine, 17: 4486

**LANTHANUM ALLOYS**

Gd–La, phase studies, 17: 4981

La–Y, phase studies, 17: 4981

**LANTHANUM CHLORIDES**

$LaCl_3$–KCl, composition and thermodynamic functions of vapor phase, 17: 5284

**LANTHANUM OXALATES**

decomposition of hydrate, 17: 4543

**LATHROP WELLS QUADRANGLE (NEV.)**

geologic map of, 17: 4726

**LEAD**

L-shell fluorescence yields of, 17: 5135

shielding properties of, in high-energy accelerators, 17: 5057

superconductivity in, surface energy parameter for, 17: 4953

superconductivity of cylinders of, 17: 5084

viscosity of, relation of atomic mobility to, 17: 4945

x-ray scattering by, Kohn anomaly measurement by, 17: 5146

**LEAD ALLOYS**

Bi–Pb, corrosive effects on ferritic steels by eutectic melt of, 17: 4906

In–Pb, structure of liquid, x-ray diffraction studies, 17: 4977

Pb-Hg, use in radiation shielding, 17: 5529(P)

Pb–Pu, phase diagram, 17: 4984

**LEAD CRYSTALS**

electron-phonon interactions in, 17: 5146

**LEAD ISOTOPES**

energy levels of, theory of low-lying vibrational, 17: 5365

proton reactions (p,xn) in, production of bismuth-205, 17: 5098

**LEAD ISOTOPES Pb-207**

x-ray spectra of, below 90 kev, 17: 4857

**LEAD ISOTOPES Pb-208**

energy levels of, lifetimes of, 17: 5335

**LEAD ISOTOPES Pb-210**

content in uraninites in Yugoslavia, 17: 4709

**LEAD OXIDE FILMS**

radiation effects on, on glass, 17: 5020

**LEAD OXIDES**

$PbO$–$TiO_2$–$ZrO_2$, phase studies, 17: 4963

**LEAD PERCHLORATES**

reactions with dioxane, structure of addition compound formed in, 17: 4452

**LEAD SYSTEMS**

Pb–Te–Sn, electric and thermal properties, 17: 4886(R) (AD-275610)

**LEAD, TETRAPHENYL-**

luminescence quenching effects on diphenylanthracene and p-terphenyl in benzene and cyclohexane solutions, 17: 4564

**LEAKS**

detection in buried oil pipelines, radiometric, 17: 4768(P)

**LEAVES**

analysis of Magnolia, 17: 4561(R) (UCRL-10350)

**LEPTONS**

decay of, consequences of conserved currents in, 17: 5219

inclusion in isospace, 17: 5266

theory, 17: 5272

**LEUKEMIA**

incidence in Hiroshima bomb survivors, 17: 4399

**LEUKOCYTES**

radiation effects on blood of, 17: 4402

**LEUKOPENIA**

radioinduced by exposure to hypophysis, 17: 4407

**LEVEL REGULATORS**

design for radioactive liquids during boiling-down, 17: 4783

**LIFE SPANS**

radiation effects on, in mice, 17: 4418

**LIGHT**

scattering by atomic hydrogen, cross section for coherent, 17: 5137

scattering by neutron-irradiated vitreous silica, 17: 4952

**LIGHT SOURCES**

description and production of low-intensity standard, 17: 4789

design and operation of spark-discharge, 17: 4773 (TID-14796)

**LIGHTNING**

decay mechanism of fireball phenomena, 17: 5455

generation of ball, application of plasma theory to, 17: 5518

**LINEAR ACCELERATORS**

design of electron, as synchrotron 40-Mev injector, 17: 5415

design of, for ions, 17: 5428(P)

focusing properties of pre-, effects of beam current on, 17: 5153

tandem loading reduction in, 17: 5427(P)

**LIQUID FLOW**

instabilities in electrically conducting, in magnetic fields, 17: 4681

**LITHIUM**

energy of ground-state, exchange correction for adiabatic approximation of, 17: 5156

gamma reactions (γ,p), polarization of protons from, 17: 5389

neutron scattering by, effects of tantalum target backing on, 17: 5348

reactions with air and its component gases, 17: 4522

separation by electrophoresis on zirconium phosphate paper, 17: 4467

separation from calcium, potassium, and sodium by amalgam exchange, 17: 4635

viscosity of, relation of atomic mobility to, 17: 4945

**LITHIUM ALLOYS**

Al-Li, phase diagram of, 17: 4930 (NMI-7010)

**LITHIUM ANTIMONY FLUORIDES**

crystal structure, 17: 4502

**LITHIUM BOROHYDRIDES**

- solubility in ethyl ether at 1 to 39°C, 17: 4517

**LITHIUM CARBONATES**
- reaction with uranium(VI) oxides, 17: 4622

**LITHIUM CHLORIDES**
- spectra of labeled, molecular beam, 17: 4554

**LITHIUM FERRATES**
- nuclear magnetic resonance of iron-57 in, 17: 5113

**LITHIUM FLUORIDE CRYSTALS**
- adsorption of water vapor on, 17: 4545
- radiation effects on color centers and flow stress of, gamma, 17: 5000
- radiation effects on dimensional stability at room temperature, 17: 5018

**LITHIUM FLUORIDES**
- spectra of labeled, molecular beam, 17: 4554
- spectra of, radiofrequency, 17: 4499 (UCRL-10482)
- spectra of uranium-activated, relaxation luminescence, 17: 5125(T)

**LITHIUM GLASS**
- characteristics for neutron detection, 17: 4835

**LITHIUM HYDRIDES**
- solubility in ethyl ether at room temperature, 17: 4517

**LITHIUM HYDROXIDES**
- solubility and vapor pressure depression in water at high temperatures, 17: 4520

**LITHIUM ISOTOPES**
- distribution of, in various natural minerals and ores, 17: 4445 (IS-500(Sect.C))

**LITHIUM ISOTOPES Li-6**
- deuteron reactions $(d,\alpha)$ at 0 to 5 Mev, 17: 5322 (NP-12258)
- energy levels of, effects of nucleon interactions on, 17: 5366
- meson $(\mu^-)$ lifetimes and capture in, 17: 5324 (NYO-9286)
- neutron reactions (n,t) at 150, 200, and 250 kev, differential cross sections for, 17: 5338
- proton scattering by, explanation of quasi-elastic, 17: 5379

**LITHIUM ISOTOPES Li-7**
- energy level at 480-kev, mean lifetime and width, 17: 5386
- meson $(\mu^-)$ lifetimes and capture in, 17: 5324 (NYO-9286)
- neutron reactions $(n,n'\gamma)$ on, cross sections for, 17: 5357

**LITHIUM OXIDES**
- $BeO-Li_2O$, fusion energy measurement of, 17: 4950

**LIVER**
- phosphorus-32 uptake by phospholipids in, in irradiated and normal mice, 17: 4419
- radiation effects on glycogen metabolism, 17: 4393
- radiation effects on bacteria infiltration into, in dogs, 17: 4433

**LUBRICANTS**
- development and properties of radiation-insensitive, 17: 4957
- development of, for nuclear technological uses, 17: 4973

**LUTETIUM**
- reactions with benzophenone, spin distribution in, 17: 4535
- separation by electrophoresis on zirconium phosphate paper, 17: 4467

**LUTETIUM IONS**
- reduction mechanisms of alcoholic lithium chloride solutions of trivalent, polarographic studies of, 17: 4507

**LYMPH SYSTEM**
- radiation effects on bacteria infiltration into, in dogs, 17: 4433

## M

**MAGNESIUM**
- casting, 17: 4910(R) (MAB-139-M(C7))
- electric mobility in bismuth (liquid) at 500°C, 17: 4946
- reactions with benzophenone, spin distributions in, 17: 4535
- viscosity of, relation of atomic mobility to, 17: 4945

**MAGNESIUM ALLOYS**
- Mg–Nd, electric resistivity of, 17: 4951
- Mg–Pu, phase diagram, 17: 4984
- Mg–Th, electric conductivity of, 17: 4446 (IS-500(Sect.E))

**MAGNESIUM BROMIDES**
- polymerization of, spectra of, 17: 4530

**MAGNESIUM CHLORIDES**
- polymerization of, spectra of, 17: 4530

**MAGNESIUM FLUORIDES**
- polymerization of, spectra of, 17: 4530

**MAGNESIUM IODIDES**
- polymerization of, spectra of, 17: 4530

**MAGNESIUM ISOTOPES Mg-24**
- nuclear structure of, $\alpha$-particle model of, 17: 5374

**MAGNESIUM ISOTOPES Mg-25**
- helium nucleus reactions (helium-3,t), spectra from, 17: 5391

**MAGNESIUM ISOTOPES Mg-26**
- energy level of, existence of $0^+$ first, 17: 5376
- helium nucleus reactions (helium-3,t), spectra from, 17: 5391

**MAGNESIUM PERCHLORATES**
- reactions with dioxane, structure of addition compound formed in, 17: 4452

**MAGNET COILS**
- current density distributions in, calculation of, 17: 4784

**MAGNETIC FIELDS**
- charged particle motions in spiral ridge, 17: 5424
- design of axially-symmetric, numerical method for, 17: 4784
- effects on plasma in krypton discharge, 17: 5460
- focusing properties of homogeneous, with straight-line boundary, 17: 5157
- generation of square-wave alternating, for nuclear spectroscopy, 17: 4794
- gravity waves in conducting fluid in, 17: 5476
- interaction of shock waves with, 17: 5459
- measurement of time-varying, 17: 5425
- plasma containment in Heliotron, 17: 5475
- plasma kinetic equation in strong static, 17: 5447
- plasma kinetics in weak, 17: 5446
- uses of saw-toothed time-varying, in plasma heating, 17: 5442 (UCRL-6355)

**MAGNETIC MATERIALS**
- electrodynamic field equations for magneto-electric, 17: 5126

**MAGNETIC MIRROR MACHINES**
- spectra of impurities in Scylla, 17: 5515

**MAGNETIC MIRRORS**
- plasma production by neutral atom injection in, 17: 5473

**MAGNETIC MOMENTS**
- plasma interaction with two-dimensional dipole, 17: 5477

**MAGNETIC PROPERTIES**
- electrodynamic field equations for magneto-electric media, 17: 5126

**MAGNETISM**
- theory of ferro- and antiferro-, in cubic clusters of spins, 17: 5027 (AD-273950)

**MAGNETITES**
- nuclear magnetic resonance of iron-57 in, 17: 5113

**MAGNETOHYDRODYNAMIC CELLS**
- design for power generation, 17: 5629
- electrical energy generation by, preliminary studies of, 17: 5527
- ionization in, nonequilibrium, 17: 5479
- materials development, 17: 5639(R) (DCAS-TDR-62-32)
- power generation by, efficiency of, 17: 5628

**MAGNETOHYDRODYNAMICS**
- book: *Fluid Mechanics and Magnetohydrodynamics*, 17: 5519
- correspondence between fluid magnetodynamic flow and ordinary gas flow, 17: 4678
- current-layer diffusion in one-dimensional pinch, 17: 5474
- equations and hypotheses of, 17: 5522
- extremely low-frequency waves in inhomogeneous hydromagnetic medium and geomagnetic micropulsations, 17: 5433 (D1-82-0150)
- flow, formulation of quasi one-dimensional, 17: 5523
- flow of incompressible conducting fluids in annuli in, 17: 4682
- flow of incompress viscous fluid in rectangular channel, laminar, 17: 4683
- flow, turbulence and charge loss in transverse magnetic field, 17: 5525
- flows of electrically conducting liquids in, instabilities in, 17: 4681
- gravity waves of a conducting fluid in a horizontal magnetic field, 17: 5476
- incompressible flow in, general characteristics of two-dimensional, 17; 5483
- industrial applications of, review of, 17: 5526
- interaction of cylindrical shock wave with magnetic field in a conducting fluid, 17: 5459
- laminar flow in porous wall annulus, 17: 5467

moment equations for gases in, 17: 5129
plane flows in, general results on theory of, 17: 5524
plasma Poiseuille flow in, 17: 5494
power generation efficiency of Carnot-cycle magnetoplasmadynamic generators, 17: 5088
properties in analogy to plasma physics, 17: 5520
rocket thrust vectoring by, 17: 5641 (NP-12264)
shock structure without collisions, 17: 5487
simple waves and shocks in, 17: 5489
stability in, two-stream, 17: 5441 (TID-17370)
stability of a heterogeneous shear layer in a magnetic field, 17: 5484
stability of system equilibria in, solution using an energy principle, 17: 5521
stability of vortex flow, nondissipative and incompressible analysis, 17: 4661 (ORNL-TM-402)
theory of thin flanges in, 17: 4664
theory of thin flanges in, with orthogonal magnetic field, 17: 5077
transverse flow past a semi-infinite plate, 17: 5485
turbulence studies in, 17: 5435(R) (DCAS-TDR-62-45)
wave propagation in partly ionized gases, 17: 5468

**MAGNETS**
operation of mass spectrometer electro-, 17: 4554
properties of superconductors as permanent, 17: 5084
superconducting, uses of, 17: 4647

**MALEIC ACID, DERIVATIVES**
excretory effects of maleate on, 17: 4391

**MALEIC ANHYDRIDE**
reaction with 2-methylfuran, deuterium isotope effect in Diels-Alder, 17: 4568

**MAN**
genetic effects of atomic-bomb radiation on, in Japan, 17: 4381
radiation effects on, diagnosis and therapy of, 17: 4754
thorotrast deposits in organs in, effects of, 17: 4414

**MANGANESE**
determination in sea water, activation, 17: 4469
separation from plutonium by anion exchange, 17: 4629

**MANGANESE ALLOYS**
Mn–Pu, phase diagram, 17: 4984

**MANGANESE COMPLEXES**
reactions of hematoporphyrin, with water, 17: 4561(R) (UCRL-10350)

**MANGANESE FLUORIDES**
fluorine-19 nuclear magnetic relaxation in, 17: 5402

**MANGANESE ISOTOPES Mn-50**
positron decay, 17: 5325 (PUC-1962-62)

**MANGANESE ISOTOPES Mn-54**
gamma angular distribution of, oriented in antiferromagnetic $CoCl_2 \cdot 6H_2O$, 17: 4509
nuclear orientation in manganese silicon fluoride crystals, 17: 4510
production in thick iron targets by protons at 3 Bev, 17: 5336

**MANGANESE ISOTOPES Mn-56**
beta spectrum, 17: 5387

**MANGANESE SILICON FLUORIDES**
structure of crystalline hexahydrated, 17: 4510

**MANNOSE**
decomposition of carbon-14-labeled, in storage, 17: 4599

**MARITIME REACTORS**
lubricants for, development and properties of, 17: 4957

**MASS SPECTROGRAPHY**
use for moisture determinations, review, 17: 4465

**MASS SPECTROMETERS**
ion-optical properties of magnetic-field, 17: 4796

**MATERIALS TESTING**
eddy current technique for measuring tube-to-tube annulus, 17: 4689

**MATERIALS TESTING REACTOR**
fuel element fabrication for, 17: 4918
moderator stored energy, 17: 5014

**MATHEMATICAL TABLES**
secant integrals of first and second kinds, 17: 4881

**MATHEMATICS**
algebraic structures and differential topology, 17: 4878 (TID-17355)
conformal invariance in, 17: 5572
Coulomb Green Function, integral representation for, 17: 4884
density matrix representations, 17: 5051
diffusion functions for small argument, 17: 4883
heat generation and transfer in reactors, 17: 5586
iteration, calculation of optimum parameters in alternating-direction-implicit, 17: 4880
meson field theory, self-coupled, 17: 5230
multi-group diffusion methods for reactor analysis, 17: 5581 (NYO-10206)
renormalization of elementary particle state vectors, 17: 5269
solution of Boltzmann transport equation, 17: 5539
solution of Maxwell's equations for magneto-ionic media with sources, 17: 5530 (AFCRL-62-247)
splitting of the Riemann tensor, 17: 5568
synthetic method applications to slab geometry problems, 17: 5303 (TID-15405)
synthetic method solution of transport equation, 17: 5302 (TID-15404)
variational procedure for calculating fast few-group constants, 17: 5298 (KAPL-2220)

**MATTER**
electrodynamic properties of magneto-electric, 17: 5126
neutron diffraction by, review of, 17: 5059

**MECHANICAL DRIVES**
development of magnetic coupling for, for use in space power transmission systems, 17: 5642(R) (NP-12270)

**MECHANICS**
expansion of circular cylindrical tubes under dynamic loads, 17: 4642(T) (UCRL-Trans-876(L))

**MEDICAL SUPPLIES**
radiosterilization of surgical materials, 17: 4761
radiosterilization of surgical materials, properties of electrons for, 17: 4762
radiosterilization of adhesive dressings, economics and effectiveness of, 17: 4763
sterilization of surgical materials, conference on, 17: 4760

**MEMBRANES**
radiation effects on sodium transport across erythrocyte, reaction mechanisms, 17: 4412

**MERCAPTO GROUP**
radioprotective effects on lens of eyes, 17: 4441

**MERCURY**
alloying effects on neutron-irradiation annealing in gold, 17: 5012
solubility in water at 25 to 90°C, activation study, 17: 4451
viscosity of, relation of atomic mobility to, 17: 4945

**MERCURY ALLOYS**
Hg–Pu, phase diagram, 17: 4984
Pb-Hg, use in radiation shielding, 17: 5529(P)

**MERCURY CHLORIDES**
spectra in argon, krypton, and xenon matrices, infrared, 17: 4497 (UCRL-10451)

**MERCURY COMPOUNDS**
organic, luminescence quenching effects on diphenylanthracene and p-terphenyl in benzene and cyclohexane solutions, 17: 4564

**MERCURY ELECTRODES**
use in polarographic studies of reduction mechanisms of alcoholic lithium chloride solutions of trivalent lanthanide ions, 17: 4507

**MERCURY HYDRIDES**
spectrum, isotope shift in emission, 17: 5109

**MERCURY PERCHLORATES**
reactions with dioxane, structure of addition compound formed in, 17: 4452

**MERCURY QUADRANGLE (NEV.)**
geologic map of, 17: 4728

**MERCURY SULFIDES**
preparation of single-crystal, 17: 5039(R) (ORNL-3364(p.85-124))

**MESONS**
field theory for, self-coupled, 17: 5230
field theory for vector, formulation of renormalizable, 17: 5211
hypothetical M meson and generalization of the Pomeranchuk relations, 17: 5250
interactions with nucleons, fixed-fermion field theory for, 17: 5210
interactions with baryons, higher symmetries of, 17: 5224
production in high-energy interactions, model for multiple, 17: 5399

production in proton pair annihilation, 17: 5273

**MESONS ($a$)**

production in N-N and $\pi$-N collisions, 17: 5276

**MESONS ($\eta$)**

properties of, 17: 5259

**MESONS (K)**

decay rates of, conserved currents in, 17: 5219

effective-mass distribution in $\Xi$ (K-$\bar{K}$) systems, 17: 5254

interactions of, review of properties of strong, 17: 5054

interactions with nucleons, effect of $\rho$ and $\omega$ exchanges on, 17: 5246

**MESONS ($K^-$)**

interactions with protons at 2.24 and 2.5 Bev/c, meson production in, 17: 5254

interactions with protons at 2.3 and 2.5 Bev/c, hyperon ($\Xi^-$) production in, 17: 5261

**MESONS ($K^0$)**

decay of, charge symmetry in, 17: 5272

**MESONS ($K^+$)**

decay schemes of, scintillation counter studies, 17: 5202 (TID-14840)

**MESONS ($K^{+}_{e3}$)**

decay of, electron energy spectrum in, 17: 5275

**MESONS ($\mu$)**

capture of, lepton theory of inverse, 17: 5272

photoproduction of pairs of, in carbon, 17: 5260

**MESONS ($\mu^-$)**

capture by carbon-12, probability of, 17: 5409

capture by copper, search for neutrinoless, 17: 5377

capture rates and lifetimes in beryllium, boron, carbon, lithium, and oxygen, 17: 5324 (NYO-9286)

**MESONS ($\omega$)**

decay mode ($\omega \to 2\pi + \gamma$), 17: 5244

effect of exchanges with mesons ($\rho$) on KN and $\bar{K}$N interactions, 17: 5246

**MESONS ($\pi$)**

effective-mass distribution in hyperon ($\Xi$) systems, 17: 5254

exchange potential in nucleon-nucleon interactions in momentum space, 17: 5271

interactions with mesons ($\pi$) interpretation of $\rho$ and $\zeta$ resonances in, 17: 5248

interactions with nucleons, resonances in, 17: 5268

interactions with nucleons, production of mesons ($a$) in, 17: 5276

photoproduction of pairs of, low-mass anomaly in, 17: 5257

production in meson ($\pi$)-nucleon interactions, 17: 5222

resonances of, and nuclear theory, 17: 5262

scattering of, resonances in, 17: 5274

**MESONS ($\pi^-$)**

interaction with protons at 1.25 Bev, one-$\pi$ exchange in, 17: 5251

interactions with nuclei at 4.5 Bev, 17: 5214

interactions with protons, cross sections for, 17: 5222

interactions with mesons ($\pi^+$), 17: 5252

production by proton-proton interactions at 1 Bev, 17: 5199 (AERE-R-3969)

**MESONS ($\pi^0$)**

photoproduction from hydrogen, vector-meson effects on, 17: 5253

**MESONS ($\pi^+$)**

interactions with mesons ($\pi^-$), 17: 5252

interactions with protons at 1090 and 1260 Mev, meson ($\eta$) production in, 17: 5259

interactions with protons, pion-pion interactions in, 17: 5279

photoproduction at 153.4 to 160.8 Mev, 17: 5287

production by polarized bremsstrahlung, 17: 5291

production by proton-proton interactions at 1 Bev, 17: 5199 (AERE-R-3969)

**MESONS ($\rho$)**

effect of exchanges with mesons ($\omega$) on KN and $\bar{K}$N interactions, 17: 5246

interpretation of, in meson ($\pi$)—meson ($\pi$) scattering, 17: 5248

production and properties in meson ($\pi^+$)-proton interactions, 17: 5279

**MESONS ($\rho^0$)**

production in p-$\pi$ interactions at 1.25 Bev, 17: 5251

**MESONS (X)**

decay, 17: 5276

**MESONS ($\zeta$)**

interpretation of, in meson ($\pi$)—meson ($\pi$) scattering, 17: 5248

**METABOLISM**

effects of cysteamine and cysteine on gas exchange, 17: 4437

**METAL COMPOUNDS**

spectra of volatile inorganic, 17: 4445 (IS-500(Sect.C))

**METAL CRYSTALS**

properties of binary, concentration effects on, 17: 4955

**METALLIC FILMS**

properties of normal and superconducting, 17: 5140

**METALS**

absorption of acoustic waves by, 17: 5118

brazing and soldering, 17: 4917(T)

corrosion of, bibliography on, 17: 4904 (LAMS-2779)

development of ferrous and non-ferrous, for nuclear technological uses, 17: 4973

dissolution of, in amines, 17: 4626 (HW-SA-2797)

elasticity of, methods of measuring modulus of, 17: 4934(T) (AEC-tr-5534)

electromagnetic field interaction with electrons in, 17: 5458

flow instabilities in magnetic fields, 17: 4681

pump operation and performance for liquid, electromagnetic, 17: 4643

radiation effects at 4°K, 17: 5038(R) (ORNL-3364(p.57-84))

sorptive properties for radioisotopes, 17: 4374(R) (MLM-1129)

ultrasonic extinction in, effects of drift motion of carriers on, 17: 4982

**METEORITES**

analysis for aluminum-26 and beryllium-10, 17: 4717

analysis for beryllium, fluorometric, 17: 4698

boron isotopic abundances in, 17: 5097

cosmic radiation reactions on, review of, 17: 5060

isotopes produced by cosmic rays in, review of, 17: 4693

isotopic displacements in, significance for early history of planetary system, 17: 4702

production of cosmogenic nuclides by proton bombardment in, 17: 5336

radioactivities, argon-37, argon-39, and tritium, 17: 4708

radioactivity of, presence of extinct, 17: 5167

**METEOROLOGY**

investigations in, before reactor startup, 17: 4694

**METHACRYLIC ACID**

radioinduced graft, polymerization with polyethylene in benzene and methanol solutions, 17: 4608

**METHACRYLIC ACID, ESTERS**

effects on radioinduced crosslinking of polymers, 17: 4584 (TID-7643 (p.245-58))

radioinduced graft polymerization with polyethylene, effects of hexane on, 17: 4583 (TID-7643(p.233-44))

**METHACRYLIC ACID, METHYL ESTER**

radioinduced polymerization of, in solid state, 17: 4578 (TID-7643(p.136-49))

radioinduced polymerization in wood, 17: 4589 (TID-7643(p.335-44))

radioinduced polymerization in aqueous emulsions, 17: 4596

**METHACRYLIC ACID, METHYL ESTER POLYMERS**

polymerization of pre-irradiated, with vinyl pyrrolidone, 17: 4580 (TID-7643(p.185-98))

**METHANE**

anharmonicity constants of isotopically substituted, 17: 4546(T)

formation in rare gas sensitized radiolysis of labeled propane, 17: 4601

polarizability of liquid, corrections for zero-field many-body, 17: 4526

**METHANE, DIAZODIPHENYL-**

spectrum of ground-state triplet in, paramagnetic resonance, 17: 4532

**METHANE, DICHLORO-**

effects on radioinduced polymerization of butadiene, 17: 4575 (TID-7643(p.109-17))

**METHANE, IODO-**

effects on radioinduced polymerization of butadiene, 17: 4575 (TID-7643(p.109-17))

**METHANOL**

effects on phophatase activity in chloroplasts, 17: 4380(R) (UCRL-10479)

effects on radioinduced graft polymerization, 17: 4583 (TID-7643(p.233-44))

oxidation of, mechanisms of electrochemical, 17: 4886(R) (AD-275610)

polymerization effects in methacrylic acid grafting to polyethylene,

17: 4608
scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602

**METHYLENE BLUE**
radioinduced reactions in aqueous solutions, effects of aeration, deaeration, ethanol, hydrogen, and sodium benzoate on, 17: 4592 (TID-14927)

**MICE**
growth of transplanted tumors in, effects of feeding irradiated coliform bacilli on, 17: 4408
phosphorus-32 uptake by phospholipids in liver and spleen in irradiated and normal, 17: 4419
radiation effects on hematopoietic system in, single, whole-body, 17: 4398
radiation effects on pneumococcal infection in, time factors in, 17: 4413
radiation effects on aging in, 17: 4418
radiation effects on function and structure of villus epithelium in, 17: 4420
radiation effects in, dose-rate dependence of early, 17: 4421
radiation effects on calcium-45 storage by bones of, 17: 4425
radiation lethality in, effects of propyl gallate and tocopherols on, 17: 4442
radioinduced chimeras in, two-step transplantation therapy for, 17: 4432
radiosensitivity of blood cells in, 17: 4405
radiosensitivity of spermatogonia in, relation of cell cycle stage to, 17: 4415

**MICROWAVE EQUIPMENT**
plasma diagnostics with multiple-probe, 17: 5448

**MICROWAVES**
interactions with exploding wires, 17: 5480
reflection by uniform dense plasmas, 17: 5451

**MILK**
analysis for uranium, colorimetric, 17: 4473
iodine-131 content in, in New Zealand, 17: 4690(R) (DXRL-F5)
strontium-90 content in, in Fiji Islands and New Zealand, 17: 4690(R) (DXRL-F5)

**MINE MOUNTAIN QUADRANGLE (NEV.)**
geologic map of, 17: 4722

**MINERALS**
thermonuclear activities in natural terrestrial, 17: 4716

**MINING**
radiation hygiene in uranium, 17: 4747

**MIXER-SETTLERS**
electric field in, 17: 4797(P)

**MOLECULES**
force constants of hexacarbonyls, 17: 5108

**MOLYBDENUM**
brazing to graphite, 17: 4912(R) (ORNL-TM-413)
casting, 17: 4910(R) (MAB-139-M(C7))
cesium and rubidium ion scattering by, spectra from, 17: 5154(T)
determination of traces in marine organisms, activation, 17: 4468
neutron elastic scattering cross section at 14 Mev, 17: 5393
neutron inelastic scattering cross sections at 9.6 to 12.2 Mev, 17: 5393
properties of, for use in thermionic reactors, 17: 5577 (GA-3523)
separation from plutonium by anion exchange, 17: 4629

**MOLYBDENUM STEEL**
rupture strength of chromium, in helium at 1000 and 1200°F, 17: 4980

**MOLYBDENUM SYSTEMS**
Mo-Si, heats of dissociation, 17: 4933 (WADD-TR-60-463(Pt.II))
Mo–ThO$_2$, preparation and thermionic evaluation, 17: 4886(R) (AD-275610)

**MONKEYS**
radiation effects on measle infection and immunity in, 17: 4401

**MONTE CARLO METHOD**
theory, for particle transport problems, 17: 4882
use in heat-transfer calculations for a rarefied gas, 17: 4680

**MOON**
composition, probable internal, 17: 4378

**MÖSSBAUER EFFECT**
properties and uses of, 17: 5404
uses of, at low temperature, 17: 5065

**MULTIPLICATION FACTOR**
for bare cylinders, 17: 5198 (HASL-124)
physics of, in water-type reactors, 17: 5585

**MUSCLES**
radiation injuries to, from therapy of neoplasms in early childhood, 17: 4400

## N

**NAGASAKI**
mortality of atomic bomb survivors in, from malignant neoplasms, 17: 4404
radiation effects on human populations in, 17: 4381

**NAPHTHALENE**
effects on radioinduced polymerization of butadiene, 17: 4575 (TID-7643(p.109-17))
fluorescence quenching in cyclohexane solution of, by oxygen, 17: 4566
luminescence quenching in benzene solution, effects of aromatic halides on, 17: 4563

**NAPHTHALENE, BROMO-**
luminescence quenching effects on scintillator solutions in benzene and cyclohexane, 17: 4563

**NEODYMIUM**
determination by mass spectrometry, 17: 4460(R) (GEAP-4082)
separation by electrophoresis on zirconium phosphate paper, 17: 4467
separation from nitric acid by solvent extraction with di(2-ethylhexyl) phosphoric acid, 17: 4460(R) (GEAP-4082)
separation from other rare earths by ion exchange, 17: 4460(R) (GEAP-4082)

**NEODYMIUM ALLOYS**
Mg–Nd, electric resistivity of, 17: 4951
Nd–Zr, surface tension of liquid, 17: 4943

**NEODYMIUM CHLORIDES**
NaCl$_3$–KCl, composition and thermodynamic functions of vapor phase, 17: 5284

**NEODYMIUM IONS**
reduction mechanisms of alcoholic lithium chloride solutions of trivalent, polarographic studies of, 17: 4507

**NEON**
electric discharge in, negative radiation temperature, 17: 5461
electron collisions with, lifetimes, excitation functions, densities, total cross sections, and polarization ratios of metastable state, 17: 5046 (UCRL-10477)
polarizability of liquid, corrections for zero-field many-body, 17: 4526
reactions with graphitized carbon black, gas-surface, 17: 4534

**NEON ISOTOPES**
fractionation in gaseous absorption, 17: 4511
helium-3 elastic scattering by, topical model for, 17: 5364

**NEON ISOTOPES Ne-20**
alpha fission of, carbon-12 distributions from, 17: 5368
gamma reactions $(\gamma,p)$ at 23.5 Mev, proton spectrum of, 17: 5345
nuclear structure of, $\alpha$-particle model of, 17: 5374

**NEPTUNIUM**
separation from Purex Process wastes by solvent extraction, 17: 4625 (HW-SA-2767)

**NEPTUNIUM ISOTOPES Np-237**
gamma magnetic transitions in, orbit-flip effects on, 17: 5350
nuclear orientation of, in neptunium dioxides, 17: 5056

**NEPTUNIUM OXIDES**
neptunium-237 nuclear orientation in, 17: 5056

**NERVOUS SYSTEM**
radiosensitivity of central, 17: 4393

**NEUTRINOS**
emission in meson $(\mu^-)$ capture by copper, 17: 5377
interactions in nuclear Coulomb fields, cross sections for meson (K), meson $(\mu)$, and meson $(\pi)$ production, 17: 5288

**NEUTRON-ABSORPTION ANALYSIS**
use for moisture determinations, review, 17: 4465

**NEUTRON BEAMS**
production of, shielding requirements in, 17: 5057

**NEUTRON-DIFFRACTION ANALYSIS**
methods and theory for, review of, 17: 5059

**NEUTRON MONOCHROMATORS**

development of curved and flat crystalline, for use in neutron spectrometers, 17: 4775(T) (NP-tr-923)
**NEUTRON PHOTOGRAPHY**
development, 17: 4687 (ANL-FGF-378)
**NEUTRON SOURCES**
development of cold, status of European, 17: 5296 (EANDC-22L)
**NEUTRON SPECTROMETERS**
design and development, 17: 4807 (MITNE-8)
phasing two-chopper systems of, with motor-generator drive, 17: 4838
**NEUTRON SPECTROSCOPY**
intensity increase in time-of-flight, by sweeping the beam over the target, 17: 4810(T) (AEC-tr-5540)
**NEUTRONS**
absorption in lumps with nonuniform temperature distribution, resonance, 17: 5310
absorption rate calculation using Monte Carlo method, 17: 4882
angular distributions from point source in air, functions for describing, 17: 5294 (BRL-Memo-1432)
capture by nuclei, gamma production in, 17: 5058
capture in uranium-238 cadmium ratio for, 17: 5373
decay in inner Van Allen belt, 17: 5195
decay in Van Allen belts, buildup of intensity, 17: 5067
detection and measurement in calibration of Cockcroft-Walton Accelerator, 17: 5412 (NDL-TM-6)
detection in boreholes using a scintillation counter, 17: 4863(P)
detection of, design of scintillation counter for, 17: 4839
detection of, device for, 17: 4868(P)
diffusion anisotropy in periodic lattices, 17: 5311
diffusion in air-gap geometry, Dancoff correction for, 17: 5309
diffusion in fully reflected reactors, 17: 5312
diffusion in graphite, measurement of, 17: 5293 (BNL-5987)
diffusion in thin slabs, discrete ordinate quadratures for, 17: 5313
diffusion length in water, 17: 5308
diffusion of, variational procedure for calculating fast few-group constants for, 17: 5298 (KAPL-2220)
diffusion theory, multi-group, 17: 5581 (NYO-10206)
energy spectra of, analysis by interactions with varying magnetic field, 17: 5285
flux decay in a subcritical assembly, 17: 5305
flux measurements in WWS-reactor, 17: 5582
interactions in detectors, 17: 4820
interactions with nucleons, cross sections for, 17: 5057
lifetimes in beryllium oxide, tungsten carbide, and uranium reflectors, 17: 5299 (LA-2743)
measurement of flux of, 17: 4864(P)
moderation by reactor coolant, two-thermal-group diffusion model of, 17: 5306
production in meson $\pi$-proton interactions, 17: 5252
reactions (n,n'$\gamma$) on lithium-7, cross sections for, 17: 5357
scattering at 0.10, 0.15, and 0.25 ev by water at 22°C, quasi-elastic, 17: 5297 (HW-75147)
scattering by bismuth-209 and carbon-12, distributions from, 17: 5359
scattering by liquid sodium, 17: 4976
scattering by lithium, effects of tantalum-backing on, 17: 5348
scattering by molybdenum, 17: 5393
scattering by strontium titanate single crystal, 17: 5141
scattering of, determination of J-values of s-type resonances from, 17: 5300 (NRL-5851)
scattering of, use of synthetic method for slab geometry problems in, 17: 5303 (TID-15405)
slowing down in a reactor thermal column, calculation of, 17: 5307
slowing down in moderators, effective resonance integrals for, 17: 5314
transmission resonances of s-wave, analytical program for, 17: 5295 (CEA-2156)
transport equation for, synthetic method solution of, 17: 5302 (TID-15404)
transport in heterogeneous materials, cross sections and self-shielding factors for, 17: 5301 (TID-13710)
transport theory at high energies, velocity dependent, 17: 5315
**NEVADA (NYE CO.)**
geologic map of Ammonia Tanks Quadrangle, 17: 4732
geologic map of Buckboard Mesa Quadrangle, 17: 4730
geologic map of Cane Spring Quadrangle, 17: 4720
geologic map of Camp Desert Rock Quadrangle, 17: 4721
geologic map of Frenchman Flat Quadrangle, 17: 4719
geologic map of Jackass Flats Quadrangle, 17: 4729
geologic map of Jangle Ridge Quadrangle, 17: 4734
geologic map of Lathrop Wells Quadrangle, 17: 4726
geologic map of Mercury Quadrangle, 17: 4728
geologic map of Mine Mountain quadrangle, 17: 4722
geologic map of northwest Specter Range Quadrangle, 17: 4725
geologic map of northwest Topopah Spring Quadrangle, 17: 4741
geologic map of Oak Spring Quadrangle, 17: 4739
geologic map of Paiute Ridge Quadrangle, 17: 4735
geologic map of Plutonium Valley Quadrangle, 17: 4736
geologic map of Rainier Mesa Quadrangle, 17: 4740
geologic map of Scrugham Peak Quadrangle, 17: 4724
geologic map of Skull Mountain Quadrangle, 17: 4731
geologic map of Striped Hills Quadrangle, 17: 4723
geologic map of Topopah Spring Quadrangle, 17: 4737
geologic map of Timber Mountain Quadrangle, 17: 4738
geologic map of Yucca Flat Quadrangle, 17: 4727
geologic map of Yucca Lake Quadrangle, 17: 4733
**NEVADA PROVING GROUNDS**
wind measurements in mesodecline, 17: 4701
**NEW ZEALAND**
fallout monitoring, 17: 4690(R) (DXRL-F5)
**NICHROME**
thermal decomposition of simulated, 17: 4492 (IDO-14597)
**NICKEL**
cesium ion reactions on, negative-ion yields from, 17: 5087
electric mobility in bismuth (liquid) at 500°C, 17: 4946
radiation effects on pure, reactor-neutron, 17: 5001
separation by electrophoresis on zirconium phosphate paper, 17: 4467
separation from plutonium by anion exchange, 17: 4629
**NICKEL ALLOYS**
casting, 17: 4910(R) (MAB-139-M(C7))
mechanical properties, effects of combined alternating and static stress, 17: 4965
Al–Ni–U, radiation effects on, at high temperatures, 17: 5023
Cr–Ni, neutron radiation effects on stress-rupture strength of A-286, 17: 4992
Cr–Ni–Nb, phase diagram, 17: 4978
Ni–Pu, phase diagram, 17: 4984
**NICKEL COATINGS**
diffusion-barrier properties of, for aluminum–uranium interfaces, 17: 4926 (EUR-17.f)
**NICKEL(II) COMPLEXES**
oxidation of 4-carboxy-1,2-cyclohexanedionedioxime, in alkaline media, 17: 4506
**NICKEL ISOTOPES**
energy levels of, theory of low-lying vibrational, 17: 5365
helium-3 elastic scattering by, optical model for, 17: 5364
**NICKEL ISOTOPES Ni-57**
decay scheme, 17: 5378
**NICKEL NITRATES**
thermal decomposition of hexahydrate of, 17: 4492 (IDO-14597)
**NICKEL OXIDE FILMS**
radiation effects on, on glass, 17: 5020
**NICKEL SYSTEMS**
Ni–ThO$_2$, properties of dispersion-strengthened, 17: 4967
**NIOBIUM**
casting, 17: 4910(R) (MAB-139-M(C7))
determination in ores by neutron activation of short-lived radionuclides, 17: 4481
determination using 7,8-dyhydroxy-4-methylcoumarin, 17: 4464
mechanical properties of, effects of oxygen on, 17: 4447 (IS-500(Sect. M))
movement in ground water at Savannah River Plant, 17: 4700
neutron resonance integrals, 17: 5320 (AE-81)
preparation of high-purity, 17: 4447 (IS-500(Sect.M))
production by fusion electrolysis, 17: 4901(P)
properties of, for use in thermionic reactors, 17: 5577 (GA-3523)
**NIOBIUM ALLOYS**
Al–Nb, oxidation resistance, effect of metallic additions on, 17: 4902(R)

(DRI-2061)
Al–Nb, phase equilibria of, 17: 4902(R) (DRI-2061)
Al–Nb–Ti, oxidation resistance, effect of metallic additions on, 17: 4903(R) (DRI-2075)
Cr–Ni–Nb, phase diagram, 17: 4978
Nb–Sn, microstructure and mechanical properties, 17: 4886(R) (AD-275610)
Nb–Sn, superconductivity, 17: 4886(R) (AD-275610)
Nb–Sn, superconductivity in, 17: 5084
Nb-Ta-Ti-V, fabrication and properties, 17: 4924(R) (ARF-B231-7)
Nb–Ta–Zr, superconductivity, 17: 4886(R) (AD-275610)
Nb-V, fabrication and properties, 17: 4924(R) (ARF-B231-7)
Nb–Zr, corrosion by potassium, 17: 4905(R) (NI•-12334)
Nb-Zr, performance in superconducting solenoids, 17: 4781
Nb–Zr, stress-rupture in-pile testing, 17: 5040(R) (ORNL-3364(p.125-50))
Nb–Zr, superconductivity of, effects of magnetic-field orientation on, 17: 5037(R) (ORNL-3364(p.27-56))
Nb–Zr, tensile properties at 4.2, 77, and 300°K, 17: 5037(R) (ORNL-3364(p.27-56))

**NIOBIUM ISOTOPES Nb-94**
half life, 17: 5320 (AE-81)

**NIOBIUM ISOTOPES Nb-95**
determination by coincidence counting, 17: 4845

**NIOBIUM OXIDES**
$Nb_2O_5-Ta_2O_5$, crystal structure, 17: 4505

**NIOBIUM OXYCHLORIDES**
reactions with potassium and sodium chlorides, enthalpies of formation of double compounds in, 17: 4550

**NITRIC ACID**
$HCL-HNO_3$, use for etching charged-particle tracks in silicate crystals, 17: 4999
$HNO_3-TBP-H_2O$, molecular interactions in, 17: 4446 (IS-500(Sect.E))
solvent extraction by tridodecylamine in benzene, 17: 4453

**NITRITE IONS**
scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602

**NITROGEN**
additive effects on electron transport in ionized argon, 17: 5515
determination by fast neutron activation, 17: 4479
diffusion from commercial graphite at 1000°C, 17: 4986
diffusion of krypton-85 in, 17: 4524
dissociation and recombination properties of atomic, 17: 5132
electron ionization cross sections of, 17: 5142
reactions of dry and wet, with lithium, 17: 4522
reactions with rare gases at high pressure, spectra of, 17: 4527

**NITROGEN ISOTOPES**
fractionation in gaseous absorption, 17: 4511
helium-3 elastic scattering by, optical model for, 17: 5364

**NITROGEN ISOTOPES N-14**
helium-3 reactions on, distributions from, 17: 5363
hyperfine structure of, in electron paramagnetic resonance, 17: 4533
nuclear excitation by 180° electron scattering, 17: 5388

**NITROGEN ISOTOPES N-16**
half life, 17: 5352

**NITROGEN SYSTEMS**
Fe–N, stress relaxation, 17: 5040(R) (ORNL-3364(p.125-50))
He–N, analysis of ionized, 17: 4457 (GA-3358)
H–N, analysis of ionized, 17: 4457 (GA-3358)

**NUCLEAR BATTERIES**
description of triode, with fissionable-material-coated cathodes, 17: 5068
design, 17: 5162(P)

**NUCLEAR ELECTRIC MOMENTS**
effects on forbidden transitions in hydrogenlike transitions, 17: 5124(T)
orientation of, review of dynamic and static methods for, 17: 5056

**NUCLEAR EMULSIONS**
exposure to cosmic radiation by rockets, 17: 5194
grain-counting in, charged particle discrimination by, 17: 5110

**NUCLEAR MAGNETIC MOMENTS**
orientation of, review of dynamic and static methods for, 17: 5056

**NUCLEAR MAGNETIC RESONANCE**
line shape analysis by lattice harmonics, 17: 5134
relaxation in crystals near Curie temperature, 17: 5402

**NUCLEAR MODELS**
generalized rotation-vibration model for deformed even nuclei, 17: 5331
reproduction of rotational bands by alpha-particle, 17: 5374

**NUCLEAR PARTICLES**
interactions with strange particles, review of strong, 17: 5054

**NUCLEAR PHYSICS**
book: *Annual Review of Nuclear Science, 11.*, 17: 5053
interrelations of nuclear structure with elementary particle physics, 17: 5395
research programs on, summary for Ames Laboratory, 17: 4448 (IS-500 (Sect.P))

**NUCLEAR POWER**
economic aspects of, in Tennessee, 17: 4377
program in United States, report to the President, 17: 5631
thermodynamics of reactor coolants for power generation, 17: 5615

**NUCLEAR POWER PLANTS**
description of direct-conversion, using triode concept, 17: 5068
design and development, 17: 5622
design and development, 17: 5624
design and development, 17: 5625
development in United Kingdom, uses of DIDO reactors in, 17: 5636
fuel for, economic factors in obtaining, 17: 5610
heat transfer control, 17: 4686(P)
safety of, analysis of loss-of-coolant accident in, 17: 5618
steam handling in, 17: 4755(P)

**NUCLEAR QUADRUPOLE RESONANCE**
detection and measurement of, design of alternating-magnetic-field generators for, 17: 4794
development and uses of, review of, 17: 4443 (AFOSR-2542)

**NUCLEAR REACTIONS**
analysis of (helium-3,p) and ($\alpha$,n), 17: 5396
cosmic particle, in meteorites, 17: 5060
cross sections for, effects of final-state scattering on, 17: 5356
cross sections for direct, perturbation theory for, 17: 5360
meson multiple production in, model for, 17: 5399
origin of heavy-particle stripping, 17: 5397
probabilities of double conversion and internal Compton effect, 17: 5405
proton capture, calculation of resonance widths in, 17: 5346
radial variation of the absorbing part of the nuclear optical potential, 17: 5398
resonances in compound-state, 17: 5268
spin effects in, triangle inequalities for, 17: 5544

**NUCLEAR SPIN**
orientation of, review of dynamic and static methods for, 17: 5056
theory of antiferro- and ferro-magnetism in cubic clusters of, 17: 5027 (AD-273950)

**NUCLEAR STRUCTURE**
construction of low-energy nuclear potentials, 17: 5380
generalized rotation-vibration model for deformed even nuclei, 17: 5331
relation of elementary particle physics to, 17: 5395

**NUCLEAR TECHNOLOGY**
book: *Annual Review of Nuclear Science, 11.*, 17: 5053
book: *Nuclear Power Engineering*, 17: 5630
materials development for, survey of, 17: 4973
status of, January 1962, 17: 4376 (TID-14912)

**NUCLEAR THEORY**
alpha-nucleon interaction phase shifts in, 17: 5216
construction of low-energy nuclear potentials, 17: 5380
energy levels in, determination from neutron-capture gamma spectra, 17: 5058
nucleon-nucleon effective interactions in finite nuclei, 17: 5366
nucleon-nucleon interaction potentials in, review, 17: 5055
nucleon relations to (3,3) resonance, 17: 5262
radial variation of the absorbing part of the nuclear optical potential, 17: 5398
spurious state in beta vibrations of deformed nuclei, 17: 5381

**NUCLEI**
alpha-particle scattering by, inelastic, 17: 5382
alpha-particle scattering by, inelastic, 17: 5383
beta decay of, theory of anomalous spectra in allowed, 17: 5370

- beta decay of, theory of vector interactions in, 17: 5400
- deuteron elastic scattering by, effect of the nuclear electric field on elastic, 17: 5384
- gamma absorption in, and resonance fluorescence, 17: 5404
- gamma angular distributions from oriented, 17: 5069
- gamma lifetimes of, determination by delayed-coincidence method, 17: 5354
- gamma magnetic transitions in deformed, orbit-flip effects on, 17: 5350
- hyperon (Λ) reactions, Coulomb excitation in, 17: 5286
- meson ($\pi^-$) interactions with, at 4.5 Bev, 17: 5214
- model for deformed even, rotation-vibration, 17: 5331
- neutron capture by, gamma production in, 17: 5058
- neutron diffraction by, review of, 17: 5059
- neutron reactions $(n,\nu)$ at 0.025 ev, recoil energies from, 17: 5001
- orientation of, review of dynamic and static methods for, 17: 5056
- production of very heavy, 17: 5326 (UCRL-10474)
- reactions on, perturbation theory for cross sections of direct, 17: 5360
- spontaneous fission of, with $Z \geq 98$, 17: 5326 (UCRL-10474)
- transitions in, probabilities of double conversion and internal Compton effect, 17: 5405

**NUCLEIC ACIDS**
- radiation effects on, 17: 4561(R) (UCRL-10350)

**NUCLEONS**
- decay rates of, conserved currents in, 17: 5219
- electromagnetic form factors of, 17: 5274
- interactions in finite nuclei, effects on energy levels, 17: 5366
- interactions of, review of models and potentials for, 17: 5055
- interactions with nucleons in nuclei, construction of low-energy potentials for, 17: 5380
- interactions with antihyperons, selection rules for annihilation, 17: 5289
- interactions with mesons, fixed-fermion field theory for, 17: 5210
- interactions with alpha particles, separable-potential model for, 17: 5216
- interactions with hyperons, mass-difference and strangeness effects in, 17: 5220
- interactions with antinucleons, angular distributions of, 17: 5221
- interactions with mesons, higher symmetries of, 17: 5224
- interactions with nucleons at very high energies, production of jets based on the fireball model, 17: 5231
- interactions with nucleons, diffraction effects in, 17: 5243
- interactions with mesons (K) and antimesons (K), effect of $\rho$ and $\omega$ exchanges on, 17: 5246
- interactions with hyperons (Λ), meson ($\pi$) contribution to, 17: 5247
- interactions with mesons ($\pi$), resonances in, 17: 5268
- interactions with nucleons in momentum space, phase shifts in, 17: 5271
- interactions with mesons ($\pi$) and nucleons, production of mesons ($\alpha$) in, 17: 5276
- number conservation in quantum field theory, 17: 5270
- scattering by nuclei, radial variation of the absorbing part of the nuclear optical potential in, 17: 5398
- spin interaction effect in deuteron stripping, 17: 5375
- theoretical nature of, relationship of (3,3) resonance to, 17: 5262

## O

**OAK SPRING QUADRANGLE (NEV.)**
- geologic map of, 17: 4739

**ORGANS**
- thorotrast deposits in, effects of, 17: 4414

**ORNL GRAPHITE REACTOR**
- graphite-stored energy in, 17: 5037(R) (ORNL-3364(p.27-56))

**OSCILLATORS**
- characteristics of nonlinear coupled, 17: 4770 (MATT-95)

**OSMIUM ISOTOPES Os-189**
- gamma magnetic transitions in, orbit flip effects on, 17: 5350

**OSMIUM ISOTOPES Os-191**
- gamma magnetic transitions in, orbit-flip effects on, 17: 5350

**OXAZOLES**
- diphenyl-, optical properties in benzene and cyclohexane, 17: 4565

**OXETANES**
- radioinduced polymerization of, in solid state, 17: 4578 (TID-7643(p.136-49))
- radioinduced polymerization of, in solid state, mechanisms of, 17: 4579 (TID-7643(p.150-77))

**OXIDE FILMS**
- particle track production in, by fission fragments, 17: 5017
- radiation effects on metallic, on glass, 17: 5020

**OXYGEN**
- analysis of ionized, mass spectrometric, 17: 4457 (GA-3358)
- corrosive effects on plutonium at high temperatures, 17: 4908
- determination by fast neutron activation, 17: 4479
- effects on diffusion and thermal properties of uranium dioxide, 17: 4894
- effects on photosynthesis by *Chlorella*, 17: 4380(R) (UCRL-10479)
- effects on radioinduced polymerization of acrylamide-propionamide solid solutions, 17: 4577 (TID-7643(p.127-35))
- electromagnetic absorption during d-c discharge, equation for, 17: 5207
- electron conductivity in x-ray-ionized, 17: 5072
- fluorescence quenching of scintillation solution by, 17: 4566
- meson ($\mu^-$) lifetimes and capture in, 17: 5324 (NYO-9286)
- reactions of dry and wet, with lithium, 17: 4522
- spectral effects of, in gas-filled proportional detectors, 17: 4853

**OXYGEN IONS**
- detection and tracking of, in layer-structure crystals, 17: 4998
- detection and tracking of, in silicate crystals, 17: 4999

**OXYGEN ISOTOPES**
- distribution of, in natural boron minerals, 17: 4445 (IS-500(Sect.C))
- fractionation between aqueous and gaseous carbon dioxide, effects of physical changes on, 17: 4511
- fractionation in gaseous absorption, 17: 4511
- helium-3 elastic scattering by, optical model for, 17: 5364
- ratios in tektites, 17: 5093

**OXYGEN ISOTOPES O-16**
- deuteron reactions $(d,\alpha)$ and $(d,p)$ on, spectra from, 17: 5367
- helium-3 reactions on, distributions from, 17: 5363
- nuclear excitation by 180° electron scattering, 17: 5388
- production in symmetric alpha fission of silicon-28, 17: 5369
- proton elastic scattering by, polarization effects in, 17: 5349
- proton elastic scattering by, phase-shift analysis of, 17: 5355

**OXYGEN ISOTOPES O-17**
- excited state of, lifetime of first, 17: 5353
- hyperfine structure of, in electron paramagnetic resonance, 17: 4533

**OXYGEN ISOTOPES O-18**
- energy levels of, effects of nucleon interactions on, 17: 5366

**OXYGEN ISOTOPES O-19**
- half life, 17: 5352

**OXYGEN POISONING**
- detection of, in gas-filled proportional detectors, 17: 4853

**OXYGEN SYSTEMS**
- He–O, analysis of ionized, 17: 4457 (GA-3358)
- O–Pu, phase diagram, 17: 4984

## P

**PACIFIC OCEAN**
- fallout monitoring at islands in, 17: 4690(R) (DXRL-F5)
- radiocarbon dating of deep water, 17: 4713

**PACKED COLUMNS**
- efficiency in separation of hydrogen isotopes, 17: 4875

**PAINTS**
- development of, for nuclear technological uses, 17: 4973

**PAIUTE RIDGE QUADRANGLE (NEV.)**
- geologic map of, 17: 4735

**PALLADIUM**
- electric mobility in bismuth (liquid) at 500°C, 17: 4946

**PALLADIUM ISOTOPES**
- energy levels of, theory of low-lying vibrational, 17: 5365

**PARTICLE PRECIPITATORS**
- design of, for fission products in reactor coolant gases, 17: 5600(P)

**PARTICLE STATISTICS**
- relativistic corrections to, 17: 5564

**PARTICLE TRACKS**
- detection and etching of, in silicate crystals, 17: 4999
- detection in layer-structure crystals, 17: 4998
- formation mechanism in metal and oxide films, 17: 5017

identification of, in emulsion, 17: 5110
**PARTICLES**
precipitation of atmospheric, thermal, 17: 4641 (TID-17378)
**PEACH BOTTOM POWER REACTOR**
design and development of, progress on, 17: 5623
fuel development for, coated-particle, 17: 4888 (GA-3109)
**PERSONNEL**
protection of x-ray analysis, development of system for, 17: 4748
protection program for industrial, 17: 4751
radiation effects on, diagnosis and therapy of, 17: 4754
radiation protection manual for, 17: 4744 (TID-7027)
regulations for, handling radioisotopes in USSR, 17: 4752
**PERTURBATION THEORY**
anomalous thresholds in unitary theories, 17: 5562
Huby's rules for nondegenerate Rayleigh-Schroedinger, in any order, 17: 5567
nuclear direct-reaction amplitudes in, 17: 5360
nucleon-nucleon interaction potentials in, review, 17: 5055
of field propagation through random media, 17: 5541
of many-boson systems, 17: 5561
scattering cross sections in, final-state, 17: 5356
**PHOSPHATASE ACTIVITY**
in spinach chloroplasts, effects of methanol on, 17: 4380(R) (UCRL-10479)
**PHOSPHATE ROCKS**
uranium content in, correlation with rock constituents, 17: 4695
**PHOSPHATES**
properties of, as solvents, 17: 4559 (HW-SA-2796)
**PHOSPHATIDES**
phosphorus-32 uptake by, in liver and spleen in irradiated and normal mice, 17: 4419
**PHOSPHINATES**
properties of, as solvents, 17: 4559 (HW-SA-2796)
**PHOSPHINE OXIDES**
properties of, as solvents, 17: 4559 (HW-SA-2796)
**PHOSPHINES**
properties of, as solvents, 17: 4559 (HW-SA-2796)
**PHOSPHONATES**
properties of, as solvents, 17: 4559 (HW-SA-2796)
**PHOSPHORESCENCE**
recombination mechanism in, 17: 5048(T) (UCRL-Trans-852(L))
**PHOSPHORIC ACID**
solvent extraction from water by tributyl phosphate, 17: 4454
**PHOSPHORIC ACID, ALKYL ESTERS**
solvent properties for neodymium, 17: 4460(R) (GEAP-4082)
**PHOSPHORS**
flash mechanisms in, effects of rare-earth activators on, 17: 5049(T) (UCRL-Trans-853(L))
glass, characteristics for neutron detection, 17: 4835
performance of boron-loaded liquid, 17: 4839
performance with beta emitters, as standard light sources, 17: 4789
testing of cerium-activated glass as, for alpha counting, 17: 4806 (HW-SA-2191)
**PHOSPHORUS**
abundance in peculiar magnetic stars, 17: 5178
**PHOSPHORUS ISOTOPES P-31**
gamma reactions (γ,n) to 24 Mev, cross sections of, 17: 5342
proton reactions (p,xp) at 100 to 400 Mev, cross sections for, 17: 5323 (NYO-8921)
**PHOSPHORUS ISOTOPES P-32**
dosimetry of, in external beta contact therapy, 17: 4383
effects on hematopoietic system in rabbits, recovery of, 17: 4427
effects on hematopoietic system of rabbits, 17: 4428
preparation and uses of, 17: 4616
uptake by phospholipids in liver and spleen in irradiated and normal mice, 17: 4419
**PHOTOELECTRIC CELLS**
development, 17: 4886(R) (AD-275610)
**PHOTOELECTRIC EFFECT**
emission of electrons from bodies in space, 17: 5166
**PHOTOMULTIPLIER TUBES**
cooling for reduction of thermal noise in scintillation counting, 17: 4824
use in dE/dx counters, 17: 4833
**PHOTONEUTRONS**
production by (γ,tn) reactions, excitation functions of, 17: 5347
**PHOTONS**
angular correlations in positron annihilation reactions in solids, 17: 5200 (IS-299)
dosimetry of, design of extrapolation-ionization chamber for, 17: 4858
interaction with protons, meson (π) production in, 17: 5253
interactions at high energy, Regge-pole behavior in, 17: 5263
interactions with protons, pion pair production in, 17: 5257
reactions (γ,p) with beryllium-9 at 16.89 to 57 Mev, 17: 5410
**PHOTOSYNTHESIS**
chemistry of, path of carbon in, 17: 4390
**PHYSICS**
conformal invariance in, 17: 5572
research progress on solid-state, at ORNL, September 1, 1961 to August 31, 1962, 17: 5035(R) (ORNL-3364)
**PINCH DEVICES**
development, 17: 5435(R) (DCAS-TDR-62-45)
electron density in Sceptre IV, interferometric measurement of, 17: 5463
**PINCH EFFECT**
diffusion of current-layer in one-dimensional, 17: 5474
instability in, azimuthal, 17: 5462
plasma dipole rotation in theta-, 17: 5495
**PIPES**
leak detection in buried oil lines, radiometric, 17: 4768(P)
**PITCHBLENDES**
analysis of natural, for impurities, 17: 4716
**PITUITARY GLAND**
radiation damage to, effects on leukopenia and whole-body immunity, 17: 4407
radiation effects on adrenocortical-hypophyseo function, 17: 4406
**PLANETS**
formation of, physical processes in, 17: 5167
production of Martian blue haze by solar protons, 17: 5168
**PLANTS**
analysis of herbage for uranium, colorimetric, 17: 4472
spectra of chloroplasts, leaves, and quantasomes of spinach, absorption, 17: 4380(R) (UCRL-10479)
**PLASMA**
absorption of electromagnetic radiation by, 17: 5458
absorption of electromagnetic waves in, negative, 17: 5481
acceleration in annular shock tubes, 17: 5466
behavior in theta pinches, detection of dipole rotation, 17: 5495
boundary with magnetic field, location of, 17: 5454
bremsstrahlung emission by, effects of correlations on incoherent, 17: 5502
bremsstrahlung emission and Gaunt factors of a Maxwellian electron gas, approximation formulas for, 17: 5512
coefficients of one-dimensional, Fokker-Planck, 17: 5478
collective treatment of many-body systems, 17: 5566
collision frequencies and electron densities of dense, 17: 5451
concentration of electrode material in, of arc discharge, 17: 5465(T)
conductivity tensor and dispersion equation for, 17: 5470
containment in Heliotron magnetic field, 17: 5475
cyclotron radiation from, collective effects on, 17: 5503
decay mechanism of fireball phenomena, 17: 5455
density of solar-flare, 17: 5187
diagnostics of, multiple-probe microwave, 17: 5448
diffusion in, effects of microinstabilities on, 17: 5496
diffusion of current-layer in one-dimensional, 17: 5474
eddies in, produced by velocity shear in a magnetic field, 17: 5482
electric conductivity of, relations with bremsstrahlung emission, 17: 5429 (AD-275288)
electric conductivity of turbulent, 17: 5472
electric conductivity in, 17: 5479
electric conductivity of fully ionized, high-frequency, 17: 5497
electric properties of sheath of, effects of contaminants on, 17: 5436 (DCAS-TDR-62-79)
electrodynamic properties of quantum, in a uniform magnetic field, 17: 5507
electromagnetic wave interactions with, 17: 5431 (AFCRL-62-185)

electromagnetic wave reflection from moving, in semiconductor, 17: 5513
electron density measurement in transient, 17: 5432 (AWRE-O-14/62)
electron diffusion in, 17: 5241
electron distribution in, effects of diffusion on, 17: 5437 (GCA-TR-62-8-A)
electron distribution in, methods for measurement of, 17: 5439 (PIBMRI-987-62)
electron oscillations in nondegenerate, damping of quantized longitudinal, 17: 5491
energy distributions in one-dimensional sheath of, 17: 5452
field components for wave transmitted by, 17: 5445
flow of, Poiseuille, 17: 5494
gravity waves in, in horizontal field, 17: 5476
heating of, by magnetic pumping, feasibility, 17: 5442 (UCRL-6355)
hydrodynamic models of solar corona, 17: 5169
hydromagnetic waves in, structure of collision-free, 17: 5488
incompressible flow in, general characteristics of two-dimensional, 17: 5483
instabilities in, production by collisional relaxation processes, 17: 5499
instability in azimuthally pinched, 17: 5462
instability in velocity distribution due to collisional relaxation, 17: 5514
interaction with magnetic dipole, 17: 5477
interactions with electromagnetic waves, 17: 5500
interactions with radio waves, temperature effects on, 17: 5501
interactions with external current and flux, diagnostic use of, 17: 5504
interactions with electromagnetic waves, theory for nonlinear, 17: 5506
ion velocity distribution in, relaxation of, 17: 5457
ionization by pressure at relatively low pressure, 17: 5456
kinetic equation of, in weak fields, 17: 5446
kinetic equation of, in strong magnetic field, 17: 5447
magnetic field effects on, in krypton discharge, 17: 5460
magnetogasdynamic moment equations for, 17: 5129
mechanics of irreversible processes in, 17: 5075
microwave interaction with exploding wires, 17: 5480
negative radiation temperature in cold, 17: 5461
negative resistance due to the Ramsauer effect in, 17: 5493
nonlinear propagation of an amplitude-modulated electromagnetic wave in, 17: 5509
oscillations of, Landau absorption in, 17: 5449
particle distribution functions in, one- and two-, 17: 5498
phonon absorption by electrons, 17: 5118
power generation efficiency of Carnot-cycle magnetoplasmadynamic generators, 17: 5088
production by filiform discharge emitted by fine point, 17: 5450
production by neutral atom injection, 17: 5473
production of hot rotating, 17: 5492
properties of, in analogy to magnetohydrodynamics, 17: 5520
purity effects in, 17: 5515
resonance peak in, r-f probe, 17: 5511
sheath formation, theory, 17: 5508
shock structure without collisions, 17: 5487
shock wave motion in cold, theory of plane, hydromagnetic, 17: 5517
shock wave propagation from hypersonic vehicles in, 17: 5430 (AD-276418)
shock waves in, effects of transverse magnetic fields on, 17: 5434 (DCAS-TDR-62-12)
shock waves in, flows behind magnetohydrodynamic cylindrical, 17: 5130
simple waves and shocks in, 17: 5489
stability in, two-stream, 17: 5441 (TID-17370)
stability of a collisionless plane, electrostatic, 17: 5464
stability of a heterogeneous shear layer in a magnetic field, 17: 5484
stability of high-temperature, Rayleigh-Taylor, 17: 5516
stability of, in torus, numerical studies of, 17: 5440 (TID-13633)
stability of magnetohydrodynamic equilibria using an energy principle, 17: 5521
stability of toroidal hydromagnetic equilibria with multipolar fields, 17: 5438 (MATT-89)
temperature measurement of, by photoelectric pyrometry, 17: 5443 (WADD-TR-60-676(Pt.II))
theory of, application to generation of ball lightning, 17: 5518
theory of irreversible processes in, 17: 5074
transport coefficients of, 17: 5510
transverse flow past a semi-infinite plate, 17: 5485
trapping instabilities in slightly inhomogeneous, 17: 5486
ultrasonic wave propagation in, 17: 5490
velocity of waves in, group, 17: 5444
wave damping in collisionless, 17: 5469
wave propagation in, 17: 5468
wave properties of, with doubly humped velocity distribution, 17: 5471

**PLASMA JETS**
stability of hard-core, with small electric conductivity, 17: 5453

**PLASTICS**
beta and bremsstrahlung depth-dose measurements in lucite, 17: 4851
coating with beryllium, 17: 4374(R) (MLM-1129)
coating with beryllium, 17: 4375(R) (MLM-1133)
flow curves for, 17: 4374(R) (MLM-1129)
flow curves for, 17: 4375(R) (MLM-1133)
radiation dosimetry in, equivalent to bone and muscle, 17: 4850
testing for use in glove-boxes, 17: 4374(R) (MLM-1129)

**PLATES**
heat transfer in forced-convection film boiling on, with uniform surface heat flux, 17: 4677
heat transfer of, effects of nonsteady wall temperature on incompressible, 17: 4674
unsteady free convection near infinite vertical, 17: 4672

**PLATINUM**
L-shell fluorescence yields of, 17: 5135
radiation effects on pure, reactor-neutron, 17: 5001

**PLUTONIUM**
alloying properties, 17: 4984
corrosion by air and oxygen, 17: 4908
density and viscosity of, 17: 4944
determination in air, design of apparatus for, 17: 4811
physical properties, 17: 4983
processing of, used as reactor fuel, 17: 4887 (ANL-FGF-393)
recovery from dilute impure solutions, 17: 4636(P)
separation from metals by anion exchange, quantitative, 17: 4629
specific heat, 17: 4375(R) (MLM-1133)

**PLUTONIUM ALLOYS**
corrosion of, bibliography on, 17: 4904 (LAMS-2779)
physical properties, 17: 4374(R) (MLM-1129)
Al–Pu, fabrication for MTR fuel elements, 17: 4918
Al–Pu, phase diagram, 17: 4984
Be–Pu, phase diagram, 17: 4984
Bi–Pu, phase diagram, 17: 4984
Ce–Co–Pu, density and viscosity of, 17: 4944
Ce–Pu, phase diagram, 17: 4984
Ce–Pu, phase studies, 17: 4374(R) (MLM-1129)
Ce–Pu, phase studies, 17: 4375(R) (MLM-1133)
Co–Pu, phase diagram, 17: 4984
Fe–Pu, phase diagram, 17: 4984
Hg–Pu, phase diagram, 17: 4984
Mg–Pu, phase diagram, 17: 4984
Mn–Pu, phase diagram, 17: 4984
Ni–Pu, phase diagram, 17: 4984
Pb–Pu, phase diagram, 17: 4984
Pu–Ru, phase diagram, 17: 4984
Pu–Th, phase diagram, 17: 4984
Pu-U, lattice constants of alpha, 17: 4923 (ANL-6460)
Pu–U, phase diagram, 17: 4984
Pu–Zn, phase diagram, 17: 4984

**PLUTONIUM ISOTOPES Pu-238**
separation from uranium-234, 17: 4375(R) (MLM-1133)

**PLUTONIUM ISOTOPES Pu-239**
fission energy of, thermal neutron, 17: 5334

**PLUTONIUM ISOTOPES Pu-241**
nuclear orientation of, in plutonium dioxides, 17: 5056

**PLUTONIUM(IV) OXIDES**
plutonium-241 nuclear orientation in, 17: 5056
$PuO_2$–$UO_2$, fabrication of, 17: 4898
$PuO_2$–$UO_2$, radiation effects on, 17: 4898
$PuO_2$–$UO_2$, sintering, 17: 4922(P)

**PLUTONIUM SYSTEMS**

H–Pu, phase diagram, 17: 4984
O–Pu, phase diagram, 17: 4984
**PLUTONIUM VALLEY QUADRANGLE (NEV.)**
geologic map of, 17: 4736
**PNEUMOCOCCI**
radiation effects on, in mice, 17: 4413
**POCKET CHAMBERS**
design, 17: 4869(P)
**POLONIUM ISOTOPES Po-210**
efficiency as electrogenerator power source, 17: 5645
**POLYMERIZATION**
radioinduced, conference on, at Battelle Memorial Institute, November 29 and 30, 1962, 17: 4570 (TID-7643)
radioinduced, diffusion and kinetics in grafting in, 17: 4587 (TID-7643 (p.300-18))
radioinduced, in solid state, 17: 4578 (TID-7643(p.136-49))
**POLYMERS**
radioinduced graft polymerization of, review, 17: 4582 (TID-7643(p.219-32))
radioinduced grafting of, diffusion and kinetics in, 17: 4587 (TID-7643 (p.300-18))
**POLYPHENYLS**
reconstitution of reactor-coolant, 17: 5602(P)
**POROUS MATERIALS**
viscous flow through, approximate three-point correlation function for, 17: 4679
**POSITRONS**
annihilation in solid cyclohexane as function of temperature, 17: 4567
annihilation in solids, angular correlation of photons from, 17: 5200 (IS-299)
scattering by hydrogen atoms at low energies, 17: 5278
**POTASSIUM**
content in tektites, 17: 4711
corrosive effects on refractory materials, 17: 4905(R) (NP-12334)
distribution in Cretaceous Mancos shale, 17: 4696
reactions with benzophenone, spin distributions in, 17: 4535
separation by electrophoresis on zirconium phosphate paper, 17: 4467
separation from lithium by amalgam exchange, 17: 4635
sorption by zirconium oxides, effects of previous hydrogen adsorption on, 17: 4500(T) (AEC-tr-5529)
viscosity of, relation of atomic mobility to, 17: 4945
**POTASSIUM ALLOYS**
K–Na, vapor pressure of, 17: 4947
**POTASSIUM BROMIDES**
diffusion of argon in, 17: 4927(R) (EURAEC-312)
**POTASSIUM CARBONATES**
reaction with uranium(VI) oxides, 17: 4622
**POTASSIUM CHLORIDE CRYSTALS**
luminescence of x-irradiated, 17: 5112
radioinduced color centers in, electron, 17: 5025
**POTASSIUM CHLORIDES**
diffusion of argon in, 17: 4927(R) (EURAEC-312)
radiation effects on doped, 17: 5039(R) (ORNL-3364(p.85-124))
radioinduced F- and M-band coloring in, 17: 5039(R) (ORNL-3364 (p.85-124))
reactions with niobium oxychloride, enthalpies of formation of double compounds in, 17: 4550
$CeCl_3$–KCl, composition and thermodynamic functions of vapor phase, 17: 5284
KCl–$PrCl_3$, composition and thermodynamic functions of vapor phase, 17: 5284
$LaCl_3$–KCl, composition and thermodynamic functions of vapor phase, 17: 5284
$NaCl_3$–KCl, composition and thermodynamic functions of vapor phase, 17: 5284
**POTASSIUM FLUORIDES**
diffusion of argon in, 17: 4927(R) (EURAEC-312)
nuclear spin diffusion in, interruptions in, 17: 4531
**POTASSIUM IODIDES**
nuclear spin diffusion in, interruptions in, 17: 4531
**POTASSIUM SALTS**
aliphatic, argon diffusion in, 17: 4927(R) (EURAEC-312)
**POTASSIUM SODIUM TARTRATES**
radiation effects on ferroelectric properties of, 17: 5003
**POWDERS**
heat transfer in outgassed, 17: 4668
**POWER PLANTS**
design of magnetohydrodynamic, 17: 5629
**POWER REACTORS**
book: *Nuclear Power Engineering*, 17: 5630
design and development of high-efficiency, 17: 5622
design of 300-Mw(e) high-power-density boiling-water, 17: 5607 (GEAP-3860)
fuel materials for advanced high-temperature, data compilation on, 17: 5575 (BMI-1598)
graphite dimensional changes in, 17: 5008
heat transfer from spiral-finned polyzonal fuel elements in gas-cooled, 17: 4667
lubricants for, development and properties of, 17: 4957
safety-system simplification in, review of, 17: 5584
steam generator design for, 17: 5632(P)
**PRASEODYMIUM**
enthalpy and related thermodynamic properties at 0 to 1100°C, 17: 4929 (IS-327)
separation by electrophoresis on zirconium phosphate paper, 17: 4467
**PRASEODYMIUM ACETATES**
polarography of, in anhydrous ethylenediamine, 17: 4486
**PRASEODYMIUM CHLORIDES**
Stark levels in, effects of configuration interactions on, 17: 4498 (UCRL-10460)
KCl–$PrCl_3$, composition and thermodynamic functions of vapor phase, 17: 5284
**PRASEODYMIUM ISOTOPES Pr-141**
nuclear moments of, effects of intermediate coupling on calculation of, 17: 4528
**PRASEODYMIUM ISOTOPES Pr-144**
efficiency as electrogenerator power source, 17: 5645
**PREGNANCY**
radiation effects on, gonad exposure, 17: 4423
**PRESSURE DROP**
in combined free and forced convection flow in vertical tubes, 17: 4673
**PRESSURE GAGES**
performance evaluation of unbonded strain gage transducers, 17: 4795
**PRESSURE VESSELS**
sealing of openings in, 17: 4654(P)
**PRESSURIZED WATER REACTORS**
core parameter effects on plant cost, 17: 5625
description and performance of pressure-tube, 17: 5612
description and prospects of, 17: 5611
design and efficiency of experimental, 17: 5633
development of British submarine, 17: 5613
development of British submarine, 17: 5614
neutron flux measurements in WWS, 17: 5582
steam generator design for, 17: 5632(P)
**PROPANE**
isotope effects in labeled, kinetics of hydrogen in, 17: 4562
radiolysis of labeled and unlabeled, effects of rare gases on, 17: 4601
**PROPANE, 2-BROMO-**
luminescence quenching effects on scintillator solutions in benzene and cyclohexane, 17: 4563
**PROPANE, 2-METHYL-**
isotope effects in labeled, kinetics of hydrogen in, 17: 4562
**2-PROPANOL**
scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602
**PROPENE**
formation in rare gas sensitized radiolysis of labeled propane, 17: 4601
radiolysis of liquid, 17: 4617
**PROPENE, 2-METHYL- POLYMERS**
radioinduced crosslinking of, effects of polyfunctional monomers on, 17: 4584 (TID-7643(p.245-58))
**PROPENE POLYMERS**
radioinduced crosslinking of, effects of polyfunctional monomers on, 17: 4584 (TID-7643(p.245-58))

radioinduced graft polymerization with styrene, effects of methanol on, 17: 4583 (TID-7643(p.233-44))
radioinduced graft polymerization to chloromethylstyrene, 17: 4590 (TID-7643(p.345-97))
radioinduced graft polymerization with acrylonitrile in vacuum, effects of pre-irradiation on, 17: 4607

**PROPIONAMIDE**
radioinduced polymerization of, in solutions with acrylamide, effects of oxygen on, 17: 4577 (TID-7643(p.127-35))

**PROPORTIONAL DETECTORS**
coincidence correction in, 17: 4374(R) (MLM-1129)
design and performance of carbon dioxide, for carbon-14 dating, 17: 4860
neutrons, 17: 4868(P)
spectral distortion in, by oxygen poisoning, 17: 4853

**PROPULSION**
ion beam neutralization in annular engine, 17: 5647

**PROPYL GALLATES**
protective effects against radiation lethality in mice, 17: 4442

**PROPYLENE OXIDE**
$C_3H_3N-C_3H_6O$, radioinduced polymerization of, 17: 4613

**PROPYNE, 3-BROMO-**
radioinduced polymerization of, mechanism of, 17: 4609

**2-PROPYN-1-OL-**
radioinduced polymerization of, mechanism of, 17: 4609

**PROTACTINIUM**
purification, 17: 4375(R) (MLM-1133)
separation from uranium wastes, 17: 4632

**PROTACTINIUM ISOTOPES**
helium-3 elastic scattering by, optical model for, 17: 5364

**PROTEINS**
determination of fractions of, in irradiated wheat flour, electrophoretic, 17: 4766
radiation effects on chemical and physical properties of wheat flour, 17: 4766
radiation effects on synthesis in thyroid gland, 17: 4397
radioinduced secondary reactions in, electron spin resonance study of, 17: 4429

**PROTON BEAMS**
focusing properties of, effects of beam current on, 17: 5153
production of polarized, 17: 5076

**PROTON SOURCES**
focusing properties of, effects of beam current on, 17: 5153

**PROTONS**
angular distributions of, from alpha reactions, 17: 5339
capture resonance widths, calculation, 17: 5346
detection and tracking of, in layer-structure crystals, 17: 4998
detection and tracking of, in silicate crystals, 17: 4999
interaction with mesons ($\pi^-$) at 1.25 Bev, one-$\pi$ exchange in, 17: 5251
interaction with photons, meson ($\pi$) production in, 17: 5253
interactions with protons at 1 Bev, meson ($\pi^*$) production in, 17: 5199 (AERE-R-3969)
interactions with mesons ($\pi^-$), cross sections for, 17: 5222
interactions with protons at 19.8 Bev/c, secondary particles from, 17: 5236
interactions with electrons, 17: 5239
interactions with mesons at 2.24 and 2.5 Bev/c, meson production in, 17: 5254
interactions with antiprotons and protons at 3 to 30 Bev, Regge pole model of, 17: 5255
interactions with photons, pion pair production in, 17: 5257
interactions with protons at high-momentum transfers, elastic cross sections for, 17: 5258
interactions with pions at 1090 and 1260 Mev, meson ($\eta$) production in, 17: 5259
interactions with mesons ($K^-$) at 2.3 and 2.5 Bev/c, hyperon ($\Xi^-$) production in, 17: 5261
interactions with antiprotons at 1.61 Bev/c, annihilation, 17: 5273
interactions with mesons ($\pi^+$), pion-pion interactions in, 17: 5279
interactions with nucleons, cross sections for, 17: 5057
reactions in iron at 3 Bev, spallation products from, 17: 5336
reactions ($p,\gamma$) with aluminum-27, gamma energy measurement, 17: 5321 (BRL-Memo-1392)
reactions ($p,p'$) on boron-11 and ($p,2p$) on carbon-12, spectra from, 17: 5362
reactions ($p,xp$) with nuclei at 100 to 400 Mev, cross sections for, 17: 5323 (NYO-8921)
reactions with helium, processes in, 17: 5178
scattering by carbon-12 and oxygen-16, polarization effects in elastic, 17: 5349
scattering by copper at 7.5 to 9.75 Mev, 17: 5398
scattering by lithium-6, explanation of quasi-elastic, 17: 5379
scattering by oxygen-16, phase-shift analysis of elastic, 17: 5355
spectrum in hyperon ($\Lambda$) decay, 17: 5223
tracks in emulsion, identification of, 17: 5110

**PSEUDOUREA, 2-(2-AMINOETHYL)-2-THIO-**
protective effects against radiation injuries in dogs, 17: 4440

**PUERTO RICO POWER REACTOR**
description, 17: 5611

**PULSE ANALYZERS**
gamma angular correlation with multichannel, 17: 4843

**PULSE GENERATORS (ELECTRONICS)**
design of high-voltage trapezoidal, 17: 4769 (IS-432)

**PULSE MODIFIERS**
design of attenuators, for rise times below 1.5 nsec, 17: 4791

**PULSES**
attenuator design for electric, for rise times below 1.5 nsec, 17: 4791

**PUREX PROCESS**
waste processing by solvent extraction, 17: 4625 (HW-SA-2767)

**PURINES**
radiation effects on synthesis of, in thyroid gland, 17: 4397

**PYROMETERS**
development of photoelectric, for plasma jet temperature measurement, 17: 5443 (WADD-TR-60-676(Pt.II))

**PYRROLIDONE, VINYL-**
polymerization with pre-irradiated polymethylmethacrylate, 17: 4580 (TID-7643(p.185-98))

## Q

**QUANTUM ELECTRODYNAMICS**
consequences of the postulate of a complete commuting set of observables in, 17: 5559
microscopic basis of macroscopic electrostatic and magnetostatic energy, 17: 5203 (UCRL-6499)
propagators in gauge covariant formulation, equations, 17: 5533

**QUANTUM MECHANICS**
analytic continuation of the S-matrix in angular momentum, 17: 5552
collective treatment of many-body systems, 17: 5566
conformal invariance in, 17: 5572
crystal exchange potential, Slater formula for, 17: 5147
elementary particle coupling constants in, 17: 5210
formulation of renormalizable vector meson fields in, 17: 5211
interaction of two-level system with stochastic electromagnetic field, 17: 5052
many-body problems in, review of problems and methods of resolution of, 17: 5540
normal constants of motion in, treated by a projection technique, 17: 5573
observation in, 17: 5152
operators of proper homogeneous Lorentz group in, 17: 4879
relaxation theory in, 17: 5532 (NP-12260)
simple and generalized condensation in many-boson systems, 17: 5557

**QUINONES**
determination in biological materials by paper chromatography, 17: 4380(R) (UCRL-10479)

## R

**RABBITS**
radiation effects on skin of, effects of spacial fractionation on sieve, 17: 4424
radiation effects on hemoglobin in, abdominal skin exposure, 17: 4426
radiation effects of phosphorus-32 on hematopoietic system in, recovery of, 17: 4427

  radiation effects on hematopoietic system of, phosphorus-32 and whole-body, 17: 4428
  radiosensitivity of blood cells in, 17: 4405

**RADIATION**
  absorption by the ionosphere, 17: 5469
  attenuation in shields, secant integrals, 17: 4881
  effects from incorporated chromium-51 on viability of ascitic tumor cells, 17: 4410
  effects on blood of guinea pigs, 17: 4402
  effects on chemical and physical properties of wheat flour protein, 17: 4766
  effects on function of reticuloendothelial system, 17: 4422
  effects on gas exchange in rats, protective effects of cysteamine and cysteine against, 17: 4437
  effects on hematopoietic system, 17: 4403
  effects on hematopoietic system in rabbits, recovery from phosphorus-32, 17: 4427
  effects on measle infection and immunity in monkeys, 17: 4401
  effects on mice, protective effects of propyl gallate and tocopherols against lethal, 17: 4442
  effects on pregnancies, gonad exposure, 17: 4423
  protection against sieve, on rabbits skin, 17: 4424
  protection of lens of eyes from, effects of cellular therapy, dehydration, and sulfhydryls on, 17: 4441
  transport equations, transformations between half-range and full-range angular expansion of, 17: 5206 (WAPD-T-1305)
  uses of, in industry, review of conference on, 17: 4758

**RADIATION CHEMISTRY**
  effect of pH on radical yields in gamma radiolysis of aqueous systems, 17: 4614
  of methylene blue in aqueous solution, 17: 4592 (TID-14927)

**RADIATION DAMAGE**
  detection of, limits of, 17: 5007

**RADIATION DETECTION INSTRUMENTS**
  book: *Nuclear Radiation Measuring Apparatus* (Kernstrahlungsmessgeräte), in German, 17: 4859
  book: *Physical Foundations of Radiology*, 17: 4431
  calibration of, preparation of standard radiation sources for, 17: 5009
  design of condenser chamber dosimeter, 17: 4862(P)
  design of, containing an ionization chamber, 17: 4866(P)
  design of, for neutron flux measurement, 17: 4864(P)
  for measuring low activities, 17: 4819
  for measuring weak beta rays in gases, review, 17: 4817
  requirements for monitoring low doses, 17: 4813

**RADIATION DETECTION INSTRUMENTS (PULSE TYPE)**
  description of silicon semiconductor spectrometer, 17: 4852
  design of, for gamma-ray detection, 17: 4861(P)
  design of, for monitoring alpha activity in air, 17: 4811
  design of, for neutron and gamma detection in boreholes, 17: 4863(P)
  design of portable, 17: 4867(P)
  design of small, solid-state alpha monitor, 17: 4840
  performance of scintillation counters, 17: 4841

**RADIATION DETECTORS**
  information capacity, theory, 17: 4822
  interactions of particles and radiations in, 17: 4820
  performance of chemically etched silicate crystals as, 17: 4999

**RADIATION EFFECTS**
  on diffusion, theory of dependence on displacement production rate and irradiation temperature, 17: 5040(R) (ORNL-3364(p.125-50))
  on refractory fuel compounds, conference on, 17: 4893

**RADIATION INJURIES**
  diagnosis, 17: 4395
  diagnosis and treatment of occupational, 17: 4754
  protective effects of AET against, in dogs, 17: 4440

**RADIATION MONITORING**
  equipment design for, 17: 4811
  smear techniques for surfaces, 17: 4743 (ORNL-TM-435)

**RADIATION PROTECTION**
  biological and chemical agents for, survey of, 17: 4430
  dosimetric control and industrial hygiene, 17: 4751
  manual, 17: 4744 (TID-7027)
  regulations for factories and laboratories in USSR, 17: 4752
  system development for, 17: 4748

**RADIATION SICKNESS**
  diagnosis and treatment of occupational, 17: 4754
  effects of diphacyl on hemorrhagic syndrome in, 17: 4436
  effects of drugs on, in rats, 17: 4438
  protection against, survey of biological and chemical agents for, 17: 4430
  protection against, by chemical prophylaxis and therapy, 17: 4439
  survival of lethal genes in *Drosophila melanogaster*, 17: 4434

**RADIATION SOURCES**
  development of, for thermal-photovoltaic energy conversion system, 17: 4886(R) (AD-275610)
  handling, open and sealed, safety criteria for, 17: 4752
  industrial uses of radioisotope, review of, 17: 5064
  preparation of, by deposition of thin layers of radioisotope on plexiglas, 17: 5009
  shielded container for heat-evolving, 17: 4756(P)
  uses of, in industry, review of conference on, 17: 4758

**RADIATION TARGET CANS**
  design of, for graphite, 17: 5006
  handling of, in Ispra-1 Reactor, 17: 4993

**RADIO WAVES**
  attenuation in earth's atmosphere, effects of high-altitude nuclear explosions on, 17: 5044 (RM-3391-PR)
  attenuation in low-density ionized gases, 17: 5044 (RM-3391-PR)
  interactions with plasma, temperature effects on, 17: 5501
  lens for, gaseous plasma, 17: 4803(P)

**RADIOACTIVE MATERIALS**
  handling and shipping, USSR standards for, 17: 4753
  handling, safety standards for, 17: 4752
  monitoring surfaces for, using smear techniques, 17: 4743 (ORNL-TM-435)
  surface distribution of beta-active, measurement by luminescent method, 17: 4757

**RADIOACTIVITY**
  measurement in air, 17: 4814
  measurement in waste waters, apparatus and methods for, 17: 5651
  measurement in water, continuous, 17: 4815
  measurement in water, discontinuous, 17: 4816
  measurement of low activities, 17: 4819
  transport from stratosphere to troposphere, 17: 4699

**RADIOAPPLICATORS**
  inspection of radium tubes and needles, apparatus, 17: 4649

**RADIOCHEMICAL PROCESSING PLANTS**
  materials of construction for, requirements of, 17: 4627 (HW-SA-2810)

**RADIOCHEMISTRY**
  conversion of salt solutions into compact solids, 17: 4620(P)
  research programs on, summary of, 17: 4445 (IS-500(Sect.C))

**RADIODERMATITIS**
  therapy of, using placental plasma, 17: 4435

**RADIOFREQUENCY ATTENUATORS**
  design of pulse attenuators, for rise times below 1.5 nsec, 17: 4791

**RADIOFREQUENCY SPECTROMETERS**
  design and operation of molecular-beam electric-resonance, 17: 4499 (UCRL-10482)

**RADIOGRAPHY**
  book: *Physical Foundations of Radiology*, 17: 4431
  developments of beta source for soft gamma, with minimum hazards, 17: 4688

**RADIOISOTOPES**
  emission from, causes of variations in, 17: 4374(R) (MLM-1129)
  industrial uses of, review, 17: 5064
  production in reactors, determination of specific activity of, 17: 4594
  production of short-lived, 17: 4759
  sorption by glass and metal, 17: 4374(R) (MLM-1129)
  use for measurement of cavitation and erosion damage in steel, 17: 4971

**RADIOLOGY**
  book: *Physical Foundations of Radiology*, 17: 4431

**RADIOSENSITIVITY**
  of blood cells in dogs, mice, and rabbits, 17: 4405
  of *Clostridium botulinum*, 17: 4394
  of spermatogonia in mice, relation of cell cycle stage to, 17: 4415

of tumor cells, effects of 5-chlorodeoxyuridine on, 17: 4411

**RADIOSTERILIZATION**
of adhesive dressings, economics and effectiveness of, 17: 4763
of disposable hypodermic syringes, 17: 4764
of pork muscle, effects of marbeling on chemical, organoleptic and physical properties of, 17: 4767
of surgical materials, 17: 4761
of surgical materials, properties of electrons for, 17: 4762

**RADIOTHERAPY**
dosimetry and techniques of external beta contact, 17: 4383
effects on bones, muscles, and skin, 17: 4400
of bladder carcinoma, effectiveness of, 17: 4385

**RADIUM**
analysis for actinium-227, 17: 4374(R) (MLM-1129)

**RADIUM ISOTOPES Ra-223**
half life, 17: 4374(R) (MLM-1129)
half life, 17: 4375(R) (MLM-1133)

**RADIUM ISOTOPES Ra-226**
separation from river sediments and uranium mill waste solids by leaching, 17: 5653

**RAIN WATER**
strontium-89 content in, in Fiji Islands and New Zealand, 17: 4690(R) (DXRL-F5)
strontium-90 content in, in Fiji Islands and New Zealand, 17: 4690(R) (DXRL-F5)

**RAINIER MESA QUADRANGLE (NEV.)**
geologic map of, 17: 4740

**RARE EARTH CARBONATES**
decomposition of heavy, mechanism of thermal, 17: 4553

**RARE EARTH CHELATES**
preparation and properties of, research summary on, 17: 4445 (IS-500 (Sect.C))

**RARE EARTH HALIDES**
preparation of anhydrous lanthanide, 17: 4542

**RARE EARTH IONS**
paramagnetic resonance of, 17: 5030 (AFOSR-2114)

**RARE EARTH OXALATES**
decomposition of heavy, mechanism of thermal, 17: 4553

**RARE EARTHS**
electronic and nuclear property measurement using atomic beams, 17: 5403
incorporation in barium oxide matrices, 17: 5079
nuclear moments of, effects of intermediate coupling on calculation of, 17: 4528
nuclear spin structures in heavy, 17: 5401
phase studies with metal salts, 17: 4445 (IS-500(Sect.C))
preparation and properties of, research summary on, 17: 4445 (IS-500 (Sect.C))
separation from Purex Process wastes by solvent extraction, 17: 4625 (HW-SA-2767)
separation of, from magnesium–thorium solutions, 17: 4447 (IS-500(Sect. M))

**RARE GASES**
scattering cross section determination for, 17: 5319
sputtering reactions with copper, 17: 5036(R) (ORNL-3364(p.1-26))
thermal neutron absorption determination for, 17: 5319

**RATS**
brain of, environmental effects on, 17: 4561(R) (UCRL-10350)
cesium-137 uptake and excretion by, effects of drugs on, 17: 4391
radiation effects on hematopoietic system in, single, whole-body, 17: 4398
radiation effects in, dose-rate dependence of early, 17: 4421
radiation effects on gas exchange in, effects of cysteamine and cysteine on, 17: 4437
radiation injuries in, effects of drugs on strontium-90, 17: 4438
tumors induced in, by blood of irradiated animals, influence of sex, 17: 4409

**REACTION MECHANISMS**
bibliography on isotopic exchange, 17: 4494 (SCR-512)
isotope effects on, review of, 17: 5063

**REACTOR COMPONENTS**
corrosion of, in water-cooled reactors, 17: 4907
position-indicating device for locating, 17: 5592(P)

**REACTOR CONTROL ELEMENTS**
neutron resonance absorption in lumps, 17: 5310

**REACTOR CONTROL RODS**
operating equipment for, 17: 5594(P)
shock-absorbing device for, 17: 5601(P)

**REACTOR CONTROL SYSTEMS**
description of self-testing safety system, 17: 5609
design for water-cooled reactors, 17: 4907
design of, for closed cycle gas turbine power system, 17: 5603(P)
development of simplified, review of, 17: 5584

**REACTOR COOLANTS**
development and testing of polyphenyl, 17: 5578(R) (IDO-11002)
fission product precipitation from gaseous, 17: 5600(P)
flow control, 17: 4686(P)
neutron moderation by, two-thermal-group diffusion model of, 17: 5306
properties of steam as, 17: 5579 (NDA-2132-5)
reconstitution of polyphenyl, 17: 5602(P)
thermodynamics for nuclear power generation, 17: 5615

**REACTOR COOLING SYSTEMS**
design for coolant distribution and collection, 17: 5599(P)
design for water-cooled reactors, 17: 4907
design of, to relieve thermally induced stress, 17: 5595(P)
failure of, effects on fuel temperatures, 17: 5583
heat transfer in forced-flow water, effects of channel geometry on, 17: 4662(T) (AEC-tr-5538)
safety of, analysis of loss-of-coolant accident in, 17: 5618
steam condensate removal from fuel element channels, 17: 5596(P)

**REACTOR ENGINEERING**
book: *Nuclear Power Engineering*, 17: 5630
design code SOPHY for IBM-650, 17: 4877 (CNEN-141)
physics experiments on Bradwell number 1, 17: 5587

**REACTOR FUEL ELEMENTS**
coupling to neutron shield plug, 17: 4653(P)
design for water-cooled reactors, 17: 4907
fabrication of aluminum–plutonium, for MTR, 17: 4918
fabrication of uranium, clad with magnesium alloy, 17: 5589(P)
heat transfer from spiral-finned polyzonal, 17: 4667
heating of, following loss-of-coolant accidents, 17: 5583
oxidation protection using carbon–uranium system, 17: 5590(P)

**REACTOR FUEL ELEMENTS (CERAMIC)**
fabrication of uranium dioxide, 17: 4909 (GEAP-3891)
processing uranium dioxide, 17: 4628 (NAA-SR-7136)

**REACTOR FUEL ELEMENTS (DISPERSION)**
development of dispersion-type, 17: 4888 (GA-3109)

**REACTOR FUEL PLATES**
design of gradient composite, 17: 5597(P)

**REACTOR FUEL RODS**
bowing effect on prompt power coefficient in SRE, 17: 5588
fabrication of canned, 17: 5591(P)
handling apparatus for, in reactors, 17: 5604(P)
neutron multiplication in arrays of, Dancoff correction for, 17: 5309

**REACTOR FUEL TUBES**
collapse of long hollow cylinder of silicon carbide surrounded by a concentric cylinder of uranium, 17: 4958
inspection of, eddy current technique for, 17: 4689

**REACTOR FUELS**
analysis of, bibliography, 17: 4461 (JAERI-4023)
economics of, 17: 5610
processing plutonium-containing, 17: 4887 (ANL-FGF-393)
production of plutonium, 17: 4887 (ANL-FGF-393)
properties of, for high-temperature reactors, data compilation on, 17: 5575 (BMI-1598)
radiation effects, 17: 4460(R) (GEAP-4082)

**REACTOR MATERIALS**
analysis of, bibliography, 17: 4461 (JAERI-4023)
design for water-cooled reactors, 17: 4907
use of, at high temperatures, 17: 4969

**REACTOR MATRICES**
conversion ratios in enriched uranium lattices moderated by water, 17: 5576 (BNL-5985)
neutron diffusion in, Dancoff correction for, 17: 5309

neutron diffusion anisotropy in periodic, 17: 5311
neutron moderation in, dependence of effective resonance integral on, 17: 5314
neutron resonance absorption in lumps, 17: 5310
neutron transport in heterogeneous, cross sections and self-shielding factors for, 17: 5301 (TID-13710)

**REACTOR MODERATORS**
neutron diffusion in, Dancoff correction for, 17: 5309
neutron slowing down properties of, dependence of effective resonance integral on, 17: 5314
neutron transport theory in, velocity dependent fast, 17: 5315

**REACTOR SAFETY**
computer analysis of loss-of-coolant accident for multicircuit core nuclear power plant, 17: 5618
development of simplified systems for, review of, 17: 5584
fuel temperature increases following coolant-loss accidents, 17: 5583

**REACTOR SHIELD VOIDS**
design of, for instrument passage, 17: 5598(P)

**REACTOR SOLUTIONS**
composition of, for aqueous homogeneous reactors, 17: 5605(P)

**REACTOR THERMAL COLUMNS**
neutron slowing down in, calculation of, 17: 5307

**REACTORS**
analysis of, multi-group diffusion methods for, 17: 5581 (NYO-10206)
charge chute design for, 17: 5593(P)
development of materials for thermionic, 17: 5577 (GA-3523)
fuel temperature increases in, following coolant-loss accidents, 17: 5583
heat generation and transfer in, 17: 5586
neutron diffusion equation in fully reflected, 17: 5312
neutron emission from, in Van Allen belts, 17: 5067
startup of, meteorological investigations prior to, 17: 4694

**REFRACTORY MATERIALS**
coating of, with oxidation-resistant materials, 17: 4964
extrusion of, development of dies for, 17: 4911(R) (NMI-9700.3)
radiation effects on, conference on, 17: 4893
radiation effects on sintering of, 17: 4899
spinning, 17: 4916
thermal capacity at 30 to 800°C, 17: 4523
use of, in advanced reactors and rockets, 17: 4969

**RELATIVITY THEORY**
Cauchy's problem in, 17: 5542
Cauchy's problem in, 17: 5549
conformal invariance in, 17: 5572
coupling of graviton to asymmetric and inertial tensor of the Dirac field, 17: 5538
general relativistic approach to the Poincaré compensating stresses for the classical point electron, 17: 5551
in statistical mechanics of interacting particles, 17: 5564
invariance in quantum field theory, 17: 5121
splitting of the Riemann tensor, 17: 5568

**REMOTE-CONTROL EQUIPMENT**
design for inspecting radium tubes and needles used in radiotherapy, 17: 4649
slave-end extension for, 17: 4659(P)

**RESEARCH REACTORS**
design and efficiency of VVR, 17: 5633
flux measurements in WWS, 17: 5582
irradiation facility design for Rumanian, 17: 4991
lubricants for, development and properties of, 17: 4957
neutron flux in Munich, epithermal, fast, and thermal, 17: 5635
operation and performance of AEG, 17: 5634
removal of irradiated uranium from Ispra-1, 17: 4993
use of TRIGA in activation analysis, 17: 4483

**RETICULO-ENDOTHELIAL SYSTEM**
radiation effects on function of, 17: 4422

**RHENIUM**
determination of traces in marine organisms, activation, 17: 4468

**RHENIUM ALLOYS**
Re–U, phase studies, 17: 4447 (IS-500(Sect.M))

**RHENIUM ISOTOPES Re-187**
proton reactions (p,xp) at 100 to 400 Mev, cross sections for, 17: 5323 (NYO-8921)

**RHODIUM**
vaporization, 17: 4933 (WADD-TR-60-463(Pt.II))

**RIBONUCLEIC ACID**
radiation effects on synthesis in thyroid gland, 17: 4397

**RIBONUCLEIC ACID, DESOXY-**
macrostructure effects on x-ray-induced extinction modifications of bases, 17: 4618
thermal denaturation, effects of deuteriation and water-$d_2$, 17: 4389

**RIBOSE**
decomposition of carbon-14-labeled, in storage, 17: 4599

**ROCKET MOTORS**
thrust vectoring of, use of magnetogasdynamics in, 17: 5641 (NP-12264)

**ROCKETS**
materials for, review on, 17: 4985
radiation studies in space with nuclear emulsion, 17: 5194
sampling clouds using, 17: 4692 (UCRL-13054)
trajectories of sounding, calculation from total flight time, 17: 5066

**ROCKS**
abundance of iodine in terrestrial crustal, 17: 5172
age estimation using strontium isotopes, 17: 4706

**RUBBER**
development of, for nuclear technological uses, 17: 4973

**RUBIDIUM**
separation by electrophoresis on zirconium phosphate paper, 17: 4467
vapor pressure, 17: 4947
viscosity of, relation of atomic mobility to, 17: 4945

**RUBIDIUM CHLORIDES**
self-diffusion of ions in liquid, coefficients of, 17: 4513

**RUBIDIUM FLUORIDE CRYSTALS**
structure of, high-pressure transitions in, 17: 4536

**RUBIDIUM IONS**
scattering by molybdenum surfaces, spectra from, 17: 5154(T)
self-diffusion in molten rubidium chloride, coefficient of, 17: 4513

**RUBIES**
radiation effects on thermoluminescence of, gamma, 17: 4997

**RUSSIAN REACTORS**
design of uranium hexafluoride-fueled, 17: 5580 (NP-12239)

**RUTHENIUM**
determination of, gravimetric, 17: 4463
movement in ground water at Savannah River Plant, 17: 4700
vaporization, 17: 4933 (WADD-TR-60-463(Pt.II))

**RUTHENIUM ALLOYS**
Pu–Ru, phase diagram, 17: 4984

**RUTHENIUM ISOTOPES Ru-103**
determination by coincidence counting, 17: 4845

**RUTHENIUM ISOTOPES Ru-106**
determination by coincidence counting, 17: 4845

## S

**SAFETY**
industrial hygiene, 17: 4751
review of, at Oak Ridge Critical Experiments Facility, 17: 4742 (ORNL-TM-349)

**SALT DEPOSITS**
geology in United States, summary, 17: 4705

**SALTS**
conversion of radioactive solutions of, into compact solids, 17: 4620(P)

**SAMARIUM**
effects on flash mechanism in phosphors, 17: 5049(T) (UCRL-Trans-853(L))
separation by electrophoresis on zirconium phosphate paper, 17: 4467

**SAPPHIRES**
radiation effects on thermoluminescence of, gamma, 17: 4997

**SATELLITES**
charge accumulation and secondary electron emission by, 17: 5644 (ZPh-084)
measurements of trapped particles by 1958ε, 17: 5182
radioactivities of recovered, argon-37, tritium, and xenon-127, 17: 4708
radioactivity induced in Discoverer 17 by solar protons, 17: 5098
scanning mechanism for x-ray spectrometer for, 17: 4808 (NASA-TN-D-

1097)
**SCANDIUM CARBONATES**
decomposition of, mechanism of thermal, 17: 4553
**SCANDIUM ISOTOPES Sc-42**
positron decay, 17: 5325 (PUC-1962-62)
**SCANDIUM OXALATES**
decomposition of, mechanism of thermal, 17: 4553
**SCATTERING**
amplitude vertex parts for direct-process, 17: 5360
amplitudes for, in fixed-fermion field theory, 17: 5210
amplitudes of high-energy elastic, 17: 5217
analytic continuation of the S-matrix in angular momentum, 17: 5552
anomalous thresholds in unitary theories, 17: 5562
application of multichannel effective range theory to electron-hydrogen, 17: 5150
atomic beam, extrema velocities of total elastic cross sections for, 17: 5090
axiomatic S-matrix theory, 17: 5569
baryon number conservation in field theory of, 17: 5270
calculation of Regge poles by continued fractions, 17: 5550
coupling constants and unsubtracted dispersion relations, 17: 5560
cross sections for final-state, 17: 5356
discontinuities in, unitarity of, 17: 5543
dispersive formulation of Levinson theorem for, 17: 5228
energy exchange in Maxwellian gases, 17: 5128
energy-momentum conservation in, restrictions imposed by Boltzmann equation on, 17: 5205 (UCRL-6559-T)
higher Born approximations for Coulomb, of a spinless particle, 17: 5558
irreducible representations in, reduction of 8-dimensional representations into, 17: 5545
iteration-variation method for atomic, 17: 5565
origin of heavy-particle stripping, 17: 5397
partial wave amplitudes, analytic continuation of, 17: 5548
properties of S-wave, 17: 5227
rearrangement collisions in, integral equation for uniqueness of, 17: 5204 (UCRL-6558-T)
Regge trajectories for the square-well potential, 17: 5554
S-matrix theory of strong interactions without elementary particles, 17: 5570
solution of Boltzmann transport equation, 17: 5539
spin effects in, triangle inequalities for, 17: 5544
symmetries in, inhomogeneous Lorentz group, 17: 5229
theory of, of highly singular potentials, 17: 5553
transition amplitudes in, analyticity and unitarity of general, 17: 5547
transport in, transformation of equations for, 17: 5206 (WAPD-T-1305)
two-particle, amplitude variation with energy and momentum transfer in, 17: 5264
validity of the Rosenbluth formula in implication of Regge poles, 17: 5555
**SCINTILLATION DETECTORS**
calibration of Geiger-Müller counters with, 17: 4842
cooling of photomultiplier tubes in, 17: 4824
design of boron-loaded liquid, 17: 4839
design of dE/dx, with photomultiplier, 17: 4833
design of liquid, for use with a Cherenkov system to study meson (μ) interactions with nuclei, 17: 4809 (NP-12248)
design of liquid, for measurement of carbon-14-labeled compounds, 17: 4821
design of portable, 17: 4715
design of total-absorption, for high-energy photons, 17: 4854
efficiency measurement in organic, for high-energy neutrons, 17: 4836
liquid, review, 17: 4818
performance of crystal, 17: 4841
preparation of, by deposition of zinc sulfide layer on plexiglas, 17: 4847
testing of cerium-activated glass as, 17: 4806 (HW-SA-2191)
**SCRUBBERS**
design for removal of halogen-acid off-gases, 17: 5648
**SCRUGHAM PEAK QUADRANGLE (NEV.)**
geologic map of, 17: 4724
**SEA WATER**
analysis for manganese and zinc, activation, 17: 4469
**SEALS AND GLANDS**
closure of pressure vessel openings using, 17: 4654(P)
development of, for nuclear technological uses, 17: 4973
**SEISMOLOGY**
generation of shear waves by underground explosions, 17: 5107
**SELENIUM ISOTOPES Se-77**
half life of metastable state of, 17: 5352
**SELENIUM SYSTEMS**
Ce–Se, phase diagrams, 17: 4886(R) (AD-275610)
Gd–Se, phase diagrams, 17: 4886(R) (AD-275610)
**SEMICARBAZIDE**
reaction of hydrochloride with cerium, complex formation, 17: 4544
**SEMICONDUCTOR DETECTORS**
construction and performance of thin-silicon, 17: 4852
design and development, 17: 4807 (MITNE-8)
design and performance of, review of, 17: 4849
design of small, for alpha particles, 17: 4840
operation of lithium-drifted silicon junction, effects of forward ion drift, 17: 4832
performance of bulk ionization silicon, for 10- and 30-Mev protons, 17: 4837
performance of guard-ring silicon surface-barrier, for beta spectrometry, 17: 4855
performance of lithium-drifted, for beta and gamma spectrometry, 17: 4857
preparation of silicon, by lithium ion drift method, 17: 4804 (ARL-62-406)
**SEMICONDUCTORS**
carrier capture probability in nonmetallic, 17: 5036(R) (ORNL-3364 (p.1-26))
development, 17: 4885 (AD-274971)
efficiency, effects of impurities on, 17: 5638 (AFCRL-62-148)
electromagnetic wave reflection from moving plasma in, 17: 5513
ultrasound extinction in, effects of drift motion of carriers on, 17: 4982
**SHALES**
analysis for beryllium, fluorometric, 17: 4698
potassium, thorium, and uranium distribution in Cretaceous Mancos, 17: 4696
**SHIELDED CONTAINERS**
design of, for heat-evolving radiation sources, 17: 4756(P)
testing of, for enriched uranium, 17: 4745 (Y-KB-22)
**SHIELDING**
secant integrals of first and second kinds, 17: 4881
**SHIELDING MATERIALS**
design of flexible, for personnel, 17: 5529(P)
development of, for nuclear technological uses, 17: 4973
requirements for high-energy accelerators, review of, 17: 5057
**SHIPPING**
regulations for, radioactive material in USSR, 17: 4752
regulations for, radioactive material in USSR, 17: 4753
**SHIPPINGPORT PRESSURIZED WATER REACTOR**
description, 17: 5611
**SHOCK TUBES**
plasma acceleration in magnetic annular, 17: 5466
**SHOCK WAVES**
flows behind strong cylindrical magnetohydrodynamic, 17: 5130
interaction with magnetic field in conducting fluid, 17: 5459
ionization of air behind, at 0.02 to 0.2 torr, 17: 5131
motion in cold plasma, theory of plane, hydromagnetic, 17: 5517
propagation in plasma from hypersonic vehicles, 17: 5430 (AD-276418)
stability of step, through fluids, 17: 5127
structure in plasma, effects of magnetic fields on, 17: 5434 (DCAS-TDR-62-12)
**SILANES**
preparation of, for use as radiation targets, 17: 5369
**SILICATES**
charged-particle track etching in crystalline, 17: 4999
**SILICIDES**
deformation and fracture of, 17: 4886(R) (AD-275610)
**SILICON**
abundance in peculiar magnetic stars, 17: 5178
abundance in stars, 17: 5178
additive effects on aluminum–niobium alloy oxidation, 17: 4902(R) (DRI-

2061)
additive effects on aluminum–niobium–titanium alloy oxidation, 17: 4903(R) (DRI-2075)
determination by fast neutron activation, 17: 4479
lattice parameters, 17: 4489 (GAT-T-1051)
radiation effects on, in photovoltaic cells, 17: 4995
radioinduced defect introduction rates in n- and p-type, in the vicinity of the radiation damage threshold, 17: 5015
thermal capacity of, at 100 to 1100°C, 17: 4445 (IS-500(Sect.C))

**SILICON CARBIDES**
collapse of long hollow cylinder of, surrounded by a concentric cylinder of uranium, 17: 4958
thermal capacity at 30 to 800°C, 17: 4523

**SILICON COATINGS**
deposition of, on refractory metals, 17: 4964

**SILICON CRYSTALS**
radiation effects on infrared absorption spectra of n- and p-type, neutron, 17: 5010(T)
sputtering by argon ions at 1 to 5 kev, yields from, 17: 5089

**SILICON ISOTOPES Si-28**
alpha fission of, cross sections for symmetric, 17: 5369
energy levels at 12 to 13 Mev, 17: 5321 (BRL-Memo-1392)
nuclear excitation by 180° electron scattering, 17: 5388

**SILICON ISOTOPES Si-30**
proton reactions (p,xp) at 100 to 400 Mev, cross sections for, 17: 5323 (NYO-8921)

**SILICON JUNCTIONS**
performance as alpha detector, 17: 4840

**SILICON OXIDES**
analysis of colloidal, for sodium by neutron activation, 17: 4482
fabrication of fused, 17: 4931 (NP-12306)
light scattering by neutron-irradiated vitreous, 17: 4952
radiation effects on colloidal, formation of hydrogen in, 17: 4615(T)
radiation effects on surface properties of gel, 17: 5026
radioinduced dilatations in vitreous, 17: 5016
surface tension and viscosity, 17: 4933 (WADD-TR-60-463(Pt.II))
$Al_2O_3-SiO_2$, viscosity, 17: 4933 (WADD-TR-60-463(Pt.II))
$CoO-SiO_2$, viscosity, 17: 4933 (WADD-TR-60-463(Pt.II))
$SiO_2-V_2O_5$, viscosity, 17: 4933 (WADD-TR-60-463(Pt.II))

**SILICON SYSTEMS**
Au–Si, preparation by simultaneous sputtering, 17: 4892
Mo-Si, heats of dissociation, 17: 4933 (WADD-TR-60-463(Pt.II))
Si-W, dissociation pressures, 17: 4933 (WADD-TR-60-463(Pt.II))

**SILICOÖRGANIC COMPOUNDS**
luminescence quenching effects on diphenylanthracene and p-tetraphenyl in benzene and cyclohexane solutions, 17: 4564
polarizability of liquid tetrachloride, corrections for zero-field many-body, 17: 4526

**SILTS**
leaching river, for removal of radium-226, 17: 5653

**SILVER**
alpha reactions $(\alpha,p)$ at 30 Mev, angular distributions from, 17: 5339
cesium ion reactions on, negative-ion yields from, 17: 5087
coating of beryllium with, 17: 4919(P)
precipitation with copper diethyldithiocarbaminate, 17: 4475
radiation effects on pure, reactor-neutron, 17: 5001
viscosity of, relation of atomic mobility to, 17: 4945

**SILVER CHLORIDE CRYSTALS**
fission recoil tracks in, observation of, 17: 5082

**SILVER FILMS**
effects on superconducting transition temperature of, tin, 17: 5139
electron inelastic scattering by thin, theory for, 17: 5281(T)

**SILVER ISOTOPES Ag-110**
half life, 17: 5352

**SINTERING**
radiation effects on, of refractory materials, 17: 4899

**SIOUX FALLS POWER REACTOR**
description, 17: 5611

**SKIN**
radiation effects on rabbit, effects of spatial fractionation on sieve, 17: 4424
radiation injuries to, from therapy of neoplasms in early childhood, 17: 4400

**SKIN GRAFTING**
therapeutic effects in radioinduced mouse chimeras, 17: 4432

**SKULL MOUNTAIN QUADRANGLE (NEV.)**
geologic map of, 17: 4731

**SLUG CANS**
radiation damage in, detection limits of, 17: 5007

**SODIUM**
determination in silica-alumina gels by neutron activation, 17: 4482
gamma reactions $(\gamma,p)$ at 2 to 10 Mev, cross sections of, 17: 5343
heat transport efficiency in steam generators, 17: 5627
neutron scattering by liquid, at 110°C, 17: 4976
reactions with benzophenone, spin distributions in, 17: 4535
separation by electrophoresis on zirconium phosphate paper, 17: 4467
separation from lithium by amalgam exchange, 17: 4635
separation from lithium by amalgam exchange, 17: 4635
sorption by zirconium oxides, effects of previous hydrogen adsorption on, 17: 4500(T) (AEC-tr-5529)
viscosity of, relation of atomic mobility to, 17: 4945

**SODIUM ACETATES**
scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602

**SODIUM ALLOYS**
K–Na, vapor pressure of, 17: 4947

**SODIUM CARBONATES**
reaction with uranium(VI) oxides, 17: 4622
scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602
thermal decomposition of, differential thermal and x-ray diffraction analysis of, 17: 4495 (TID-13772)

**SODIUM CHLORIDE CRYSTALS**
luminescence of x-irradiated, 17: 5112
radiation effects on dimensional stability at room temperature, 17: 5018

**SODIUM CHLORIDES**
nuclear spin diffusion in, interruptions in, 17: 4531
reactions with niobium oxychloride, enthalpies of formation of double compounds in, 17: 4550
self-diffusion of ions in liquid, coefficients of, 17: 4513
spectra of labeled, molecular beam, 17: 4554

**SODIUM FLUORIDES**
spectra of uranium-activated, relaxation luminescence, 17: 5125(T)

**SODIUM FORMATES**
scavenging effects on electron and hydrogen yields in irradiated aqueous solutions, 17: 4602

**SODIUM IODIDE CRYSTALS**
nuclear spin diffusion in, interruptions in, 17: 4531

**SODIUM IODIDES**
self-diffusion of ions in liquid, coefficients of, 17: 4513
use for thermal neutron flux measurements, 17: 4825

**SODIUM IONS**
self-diffusion in molten rubidium chloride and iodide, coefficients of, 17: 4513

**SODIUM ISOTOPES Na-23**
energy level at 440 kev, mean lifetime and width, 17: 5386

**SODIUM ISOTOPES Na-24**
transport of, in lakes in Wisconsin, 17: 4715

**SODIUM REACTOR EXPERIMENT**
prompt power coefficient for, 17: 5588

**SOILS**
shielding properties of, in high-energy accelerators, 17: 5057

**SOLAR BATTERIES**
performance of high-resistivity silicon photodiodes, 17: 4646

**SOLAR FLARES**
contribution to radiation dose in space vehicles, 17: 5646
density of plasma of, 17: 5187
effect on outer Van Allen zone, 17: 5184
effects on upper atmosphere variations, 17: 5170
emission of radio and corpuscular radiation in July 1961, 17: 5181
ionospheric effects of Sept. 1961, phase observations on, 17: 5101
prediction for space flight, 17: 5164
radioactivity induced in Discoverer 17 by solar protons, 17: 5098
relations to auroral and ionospheric disturbances, 17: 5047(T) (AD-

275256)
shielding from, in lunar spacecraft design, 17: 5528
x-ray burst of September 28, 1961, 17: 5091

**SOLDERING**
processes in, 17: 4917(T)

**SOLDERS**
composition and properties, 17: 4917(T)

**SOLENOIDS**
design of variable-composition superconducting 70-kOe, 17: 4781
preparation of superconducting, 17: 4886(R) (AD-275610)

**SOLID STATE REACTIONS**
research programs on, summary for Ames Laboratory, 17: 4448 (IS-500 (Sect.P))

**SOLIDS**
electron scattering by impurity ions in, anisotropy from, 17: 5282(T)

**SOLUTIONS**
conversion of radioactive salt, into compact solids, 17: 4620(P)
level control of radioactive, in electronic boiling-down, 17: 4783
radiolysis of, effects of pH on radical yields in, 17: 4614

**SOUND**
absorption by metals, 17: 5118
velocity in helium-II at 1.19 to 2.1°K, 17: 5143

**SPACE**
cosmic radiation effects on meteorites in, 17: 5060
model of interplanetary medium, 17: 5165
photoelectric screening of bodies in, 17: 5166

**SPACE FLIGHT**
hazards from solar flares, predictions of, 17: 5164

**SPACE VEHICLES**
development of drive coupling for use in, 17: 5642(R) (NP-12270)
gamma measurements with Ranger 3, 17: 5185
materials for, review on, 17: 4985
propulsion of, electrostatic system design for, 17: 5645
radiation doses in, evaluation of, 17: 5646
shielding lunar, for optimized protection against environmental hazards, 17: 5528

**SPARK DETECTORS**
performance of acoustic, for determining track positions, 17: 4829
triggering systems for, design of fast, 17: 4856

**SPECIFIC HEAT**
of refractory materials at 30 to 800°C, 17: 4523

**SPECTER RANGE NW QUADRANGLE (NEV.)**
geologic map of, 17: 4725

**SPECTROMETERS**
construction and performance of thin-semiconductor pulse, 17: 4852
slit function corrections for, 17: 4771 (NP-12236)
use of crystal, for determination of rare gas thermal neutron absorption and scattering cross sections, 17: 5319

**SPECTROSCOPY**
apparatus and process for, of small amounts of elements in a gas, 17: 4487(P)
design of alternating-magnetic-field generators for nuclear-quadrupole-resonance, 17: 4794
development of, for use in analytical chemistry, 17: 4445 (IS-500(Sect.C))

**SPERM**
radiosensitivity of spermatogonia in mice, relation of cell cycle stage to, 17: 4415

**SPLEEN**
phosphorus-32 uptake by phospholipids in, in irradiated and normal mice, 17: 4419
radiation effects on bacteria infiltration into, in dogs, 17: 4433

**SPONTANEOUS FISSION**
in nuclei with Z ≥ 98, 17: 5326 (UCRL-10474)

**SPUTTERING**
design of system for simultaneous multicomponent, 17: 4892

**STACK DISPOSAL**
scrub tower design for removal of halogen-acid off-gases, 17: 5648

**STAINLESS STEEL**
brazing to Zircaloy-2, 17: 4889(T,R) (EURAEC-322)
cavitation and erosion damage rate of 302, 17: 4971
rupture strength of type 316 in helium at 1300 and 1500°F, 17: 4980
sputtering by argon ions at 1 to 5 kev, yields from, 17: 5089
stress-rupture in-pile testing, 17: 5040(R) (ORNL-3364(p.125-50))
thermal decomposition of simulated, 17: 4492 (IDO-14597)

**STARS**
reactions in peculiar magnetic, surface, 17: 5178

**STATISTICS**
analysis of multi-factor tables in, 17: 4381
isotope effects on chemical reaction, review of, 17: 5063

**STEAM**
control of, in turbines, 17: 4686(P)
diffusion from commercial graphite at 1000°C, 17: 4986
handling in nuclear power plants, 17: 4755(P)
properties of, for use as reactor coolants, 17: 5579 (NDA-2132-5)

**STEAM POWER PLANTS**
design of liquid metal-heated, fossil fuel-fired, 17: 5627
efficiency and economy of, development of, 17: 5628

**STEEL**
casting, 17: 4910(R) (MAB-139-M(C7))
corrosion by bismuth–lead eutectic, 17: 4906
dynamic yield behavior of explosively loaded, 17: 4949
extrusion of, development of dies for, 17: 4911(R) (NMI-9700.3)
radiation effects on stresses in, 17: 5040(R) (ORNL-3364(p.125-50))

**STELLARATORS**
plasma drift instabilities in, 17: 5499

**STERILIZATION**
of surgical materials, conference on, 17: 4760

**STRAIN GAGES**
performance evaluation of unbonded, for use as pressure transducers, 17: 4795

**STRANGE PARTICLES**
interactions of, review of properties of strong, 17: 5054
properties of new, 17: 5233

**STRATOSPHERE**
mass and radioactivity transport to troposphere, 17: 4699

**STRIPED HILLS QUADRANGLE (NEV.)**
geologic map of, 17: 4723

**STRONTIUM**
movement in ground water at Savannah River Plant, 17: 4700
separation by electrophoresis on zirconium phosphate paper, 17: 4467
separation from Purex Process wastes by solvent extraction, 17: 4625 (HW-SA-2767)

**STRONTIUM CHLORIDES**
diffusion coefficients of, tracer technique for measurement of, 17: 4549

**STRONTIUM FLUORIDE CRYSTALS**
spectra of europium and ytterbium in, absorption and luminescence, 17: 4547(T)

**STRONTIUM FLUORIDES**
spectra of uranium-activated, relaxation luminescence, 17: 5125(T)

**STRONTIUM ISOTOPES**
energy levels of, theory of low-lying vibrational, 17: 5365
use in age estimation of rocks, 17: 4706

**STRONTIUM ISOTOPES Sr-89**
content in milk and rain in New Zealand, 17: 4690(R) (DXRL-F5)
content in milk and rain in Fiji Islands, 17: 4690(R) (DXRL-F5)

**STRONTIUM ISOTOPES Sr-90**
beta depth-dose measurement in lucite, 17: 4851
content in milk and rain in New Zealand, 17: 4690(R) (DXRL-F5)
content in milk and rain in Fiji Islands, 17: 4690(R) (DXRL-F5)
determination in grass of Krakow district of Poland, June 1961, 17: 4392

**STRONTIUM NITRATES**
purification of commercial, 17: 4558(P)

**STRONTIUM OXIDES**
thermionic emission in, shallow donor, 17: 5079

**STRONTIUM PERCHLORATES**
reactions with dioxane, structure of addition compound formed in, 17: 4452

**STRONTIUM SULFATES**
solubility of, in aqueous solutions, determination of, 17: 4466
solubility of, in water, determination of, 17: 4466

**STRONTIUM TITANATES**
crystal lattice dynamics of, temperature dependence of, 17: 5141
dielectric properties, 17: 4960

**STYRENE POLYMERS**

radiation effects, 17: 5041(R) (ORNL-3364(p.151-200))
**STYRENES**
radioinduced graft polymerization with polymers, effects of methanol on, 17: 4583 (TID-7643(p.233-44))
radioinduced graft polymerization to polypropylene, 17: 4590 (TID-7643(p.345-97))
radioinduced polymerization of, in solid state, 17: 4578 (TID-7643(p.136-49))
radioinduced polymerization in aqueous emulsions, 17: 4596
**SUBMARINE REACTORS**
development of British pressurized-water, 17: 5613
development of British pressurized-water, 17: 5614
**SUGARS**
chromatographic analysis of, behavior of tetra-o-acetyl pentopyranoses, 17: 4561(R) (UCRL-10350)
derivatives of, gas–liquid partition mobilities of pyranose, 17: 4561(R) (UCRL-10350)
**SULFUR**
abundance in peculiar magnetic stars, 17: 5178
**SULFUR ISOTOPES**
helium-3 elastic scattering by, optical model for, 17: 5364
**SULFUR ISOTOPES S-31**
yield in $(\gamma,n)$ reactions in sulfur-32, 17: 5344
**SULFUR ISOTOPES S-32**
gamma reactions $(\gamma,n)$ to 24 Mev, cross sections of, 17: 5342
gamma reactions $(\gamma,n)$ at 30 Mev, cross sections of, 17: 5344
neutron elastic and inelastic scattering at 4.6 Mev, 17: 5327
proton reactions (p,xp) at 100 to 400 Mev, cross sections for, 17: 5323 (NYO-8921)
**SUN**
activity levels of, effects on upper atmosphere, 17: 5170
corona of, hydrodynamic models of, 17: 5169
formation of, physical processes in, 17: 5167
temperature measurement using a microwave radiometer at 2.04 mm, 17: 5175
**SUPERCONDUCTIVITY**
uses of, 17: 4647
**SUPERCONDUCTORS**
development, 17: 4886(R) (AD-275610)
electron tunneling in, 17: 5138
properties as permanent magnets, 17: 5084
properties of films of normal metals and, 17: 5140
transition temperature of superimposed films, 17: 5139
**SUPERHEATERS**
design of, for heat recovery from pressurized fluid, 17: 4684(P)
**SURFACE PROPERTIES**
chemistry of, review of, 17: 4516
**SURFACE WATERS**
radioisotope transport in, in Wisconsin, 17: 4715
**SURFACES**
distribution of beta-active substances on, measurement by luminescent method, 17: 4757
elemental composition of, alpha backscattering analysis of, 17: 5100
radiation monitoring of, using smear techniques, 17: 4743 (ORNL-TM-435)
**SWITCHES**
design for rapid discharge of high-energy capacitors, 17: 4782
design of cyclical, 17: 4657(P)
**SYNCHROCYCLOTRONS**
oscillator for, pulser circuit for, 17: 5418
**SYNCHROTRONS**
design of Frascati electron, 17: 5416
gamma production by, calibration of energy in, 17: 5347
injector design for, 40-Mev electron linear, 17: 5415
**SYRINGES**
radiosterilization of disposable hypodermic, 17: 4764

**T**

**TANTALUM**
cesium ion reactions on, negative-ion yields from, 17: 5087
determination in ores by neutron activation of short-lived radionuclides, 17: 4481
determination using 7,8-dyhydroxy-4-methylcoumarin, 17: 4464
neutron scattering by, on lithium targets, 17: 5348
properties of, for use in thermionic reactors, 17: 5577 (GA-3523)
tensile properties at 1000 to 3269°K, 17: 5639(R) (DCAS-TDR-62-32)
**TANTALUM ALLOYS**
corrosion of, bibliography on, 17: 4904 (LAMS-2779)
Nb-Ta-Ti-V, fabrication and properties, 17: 4924(R) (ARF-B231-7)
Nb–Ta–Zr, superconductivity, 17: 4886(R) (AD-275610)
**TANTALUM ISOTOPES Ta-181**
gamma magnetic transitions in, orbit-flip effects on, 17: 5350
**TANTALUM OXIDES**
$Nb_2O_5-Ta_2O_5$, crystal structure, 17: 4505
**TECHNETIUM**
review of search for, in nature, 17: 4449
**TEKTITES**
age estimation using potassium–argon method, 17: 4711
origin of, oxygen isotope studies of, 17: 5093
**TELLURIUM SYSTEMS**
Pb–Te–Sn, electric and thermal properties, 17: 4886(R) (AD-275610)
**TENNESSEE**
nuclear power development in, 17: 4377
**TERBIUM**
Fermi surface of, 17: 5401
separation by electrophoresis on zirconium phosphate paper, 17: 4467
**TERBIUM IONS**
reduction mechanisms of alcoholic lithium chloride solutions of trivalent, polarographic studies of, 17: 4507
**TERPHENYLS**
fluorescence quenching in cyclohexane solutions of, by oxygen, 17: 4566
luminescence quenching by organometallics in benzene and cyclohexane solution, 17: 4564
luminescence quenching in benzene solution, effects of aromatic halides on, 17: 4563
optical properties in benzene and cyclohexane, 17: 4565
thermodynamic properties, 17: 5578(R) (IDO-11002)
**TEXTILES**
radioinduced graft polymerization of vinyl monomers to, 17: 4586 (TID-7643(p.268-99))
**THALLIUM**
L-shell fluorescence yields of, 17: 5135
precipitation with copper diethyldithiocarbaminate, 17: 4475
**THALLIUM ALLOYS**
In–Tl, phase studies, 17: 4447 (IS-500(Sect.M))
**THALLIUM ISOTOPES Tl-208**
decay scheme, 17: 5335
**THERMAL CONDUCTIVITY**
measurement of, for ceramic materials, 17: 4774(T) (EURAEC-415)
**THERMAL DIFFUSION**
functions for small argument, 17: 4883
measurement of, for ceramic materials, 17: 4774(T) (EURAEC-415)
**THERMAL INSULATION**
development of, for nuclear technological uses, 17: 4973
**THERMAL NEUTRONS**
capture by chromium in dichromate solutions, chemistry of, 17: 4595
capture by nuclei, recoil energies from, 17: 5001
capture of, radiation damage by Mossbauer effect in, 17: 5036(R) (ORNL-3364(p.1-26))
detection and measurement of, ionization chamber design for, 17: 4846
diffraction of, review, 17: 5059
diffusion in beryllium, effect of Bragg cutoff on, 17: 5316
fission of uranium-236 by, neutron yields from, 17: 5351
flux measurements using sodium powders, 17: 4825
reciprocity theorems for, 17: 5304
scattering by an anharmonic crystal, 17: 5317
scattering by uniaxial antiferromagnetic materials, distributions from, 17: 5318(T)
**THERMAL PRECIPITATORS**
efficiency for atmospheric sampling, 17: 4641 (TID-17378)
**THERMAL RADIATION**
heat transfer in tubes by forced convection and, 17: 4671
**THERMIONIC CELLS**

cathodes of, zero-field emission from hollow, 17: 5083
design of heat-shielded magnetically channeled, 17: 5643 (UCRL-6553)
development, 17: 4886(R) (AD-275610)
development and operation, 17: 5637(R) (AD-275908)
development of materials for, 17: 5577 (GA-3523)
development of shallow donor emitter, 17: 5079

**THERMOCOUPLES**
design of stable, 17: 4801(P)

**THERMODYNAMICS**
efficiency of Carnot-cycle magnetoplasmadynamic generators, 17: 5088
isotope effects on chemical reaction, review of, 17: 5063

**THERMOELECTRIC CELLS**
characteristics of refrigerators and heat pumps for, 17: 5081
design of, containing fissionable material, 17: 5162(P)
development, 17: 4885 (AD-274971)
development, 17: 4886(R) (AD-275610)
development of high-temperature, 17: 4638(R) (AD-274164)
operation of, effects of impurities in materials on, 17: 5638 (AFCRL-62-148)
theory of operation of, 17: 5080

**THERMOELECTRIC MATERIALS**
criteria for high-efficiency generators, 17: 5080
development of high-temperature, 17: 4886(R) (AD-275610)

**THERMOMETERS**
description of low-temperature liquid-helium, 17: 4790

**THERMONUCLEAR EXPLOSIONS**
detection of, review, 17: 5061
energetic particle flux produced by high-altitude, of July 9, 1962, 17: 5115
geomagnetic field effects of July 9, 1962, Johnston Island shot, 17: 5106
high altitude, effects on radio signal propagation, 17: 5116
in the presence of sea water, properties of nuclear debris from, 17: 4750
magnetic disturbance from July 9, 1962, Johnston Island shot, 17: 5104
magnetic effects of July 9, 1962, Johnston Island shot, 17: 5105

**THERMONUCLEAR REACTIONS**
purity effects in, 17: 5515

**THERMONUCLEAR REACTORS**
design and operation of Homopolar V, 17: 5492

**THIOCYANATE COMPLEXES**
with thorium, separation by solvent extraction, 17: 4631

**THORIUM**
content in granodiorite, effects of chemical weathering on, 17: 4697
determination of, spectrophotometric method using Eriochrome Black T, 17: 4471
determination of, spectrophotometric method using Solochrome Fast Grey R.A.S., 17: 4476
distribution in Cretaceous Mancos shale, 17: 4696
preparation of high-purity, 17: 4447 (IS-500(Sect.M))
separation by electrophoresis on zirconium phosphate paper, 17: 4467
separation from bismuth and uranium by anion exchange, 17: 4478
separation from uranium leach waste liquors, 17: 4637(P)
separation of, from uranium-233 by magnesium dissolution, 17: 4446 (IS-500(Sect.E))

**THORIUM ALLOYS**
Mg–Th, electric conductivity of, 17: 4446 (IS-500(Sect.E))
Pu–Th, phase diagram, 17: 4984
Th–V, phase diagram, 17: 4936

**THORIUM CARBIDES**
ThC–UC, properties as reactor fuel, 17: 4888 (GA-3109)

**THORIUM COMPLEXES**
with thiocyanate, separation by solvent extraction, 17: 4631

**THORIUM ISOTOPES Th-228**
efficiency as electrogenerator power source, 17: 5645
parity levels, 17: 5331

**THORIUM OXALATES**
decomposition of hydrate, 17: 4543

**THORIUM OXIDES**
vaporization, 17: 4933 (WADD-TR-60-463(Pt.II))
Ni–$ThO_2$, properties of dispersion-strengthened, 17: 4967

**THORIUM(IV) OXIDES**
deposition in organs in man, effects of, 17: 4414
diffusion of xenon in, 17: 4927(R) (EURAEC-312)
use in renal angiography in dogs, 17: 4382
Mo–$ThO_2$, preparation and thermionic evaluation, 17: 4886(R) (AD-275610)
$ThO_2$–$UO_2$, radiation effects, 17: 5041(R) (ORNL-3364(p.151-200))

**THULIUM**
Fermi surface of, 17: 5401
separation by electrophoresis on zirconium phosphate paper, 17: 4467

**THULIUM IONS**
reduction mechanisms of alcoholic lithium chloride solutions of trivalent, polarographic studies of, 17: 4507

**THULIUM ISOTOPES Tm-169**
hyperfine structure splitting of 8.42-kev gamma radiation from, effects of temperature at 14 to 300°K on, 17: 5406

**THYMINE**
radiation effects on, in frozen aqueous solution and solid state, 17: 4380(R) (UCRL-10479)

**THYMUS**
radiation effects on bacteria infiltration into, in dogs, 17: 4433

**THYROID GLAND**
iodine-131 content in animal, in New Zealand, 17: 4690(R) (DXRL-F5)
physiology of, tracer study using iodine-132, 17: 4386
radiation effects on, from internally deposited iodine-132, 17: 4386
radiation effects on protein and RNA synthesis in, in calf, 17: 4397

**THYROXINE**
deiodination rate in humans, quantitative determination of, 17: 4386

**TIMBER MOUNTAIN QUADRANGLE (NEV.)**
geologic map of, 17: 4738

**TIN**
alloying effects on aluminum–niobium alloy oxidation, 17: 4902(R) (DRI-2061)
alloying effects on aluminum–niobium–titanium alloy oxidation, 17: 4903(R) (DRI-2075)
cesium ion reactions on, negative-ion yields from, 17: 5087
radiation effects on superconducting transition, 17: 5037(R) (ORNL-3364(p.27-56))
viscosity of, relation of atomic mobility to, 17: 4945

**TIN ALLOYS**
Nb–Sn, microstructure and mechanical properties, 17: 4886(R) (AD-275610)
Nb–Sn, superconductivity, 17: 4886(R) (AD-275610)
Nb–Sn, superconductivity in, 17: 5084

**TIN CHLORIDES**
polarizability of liquid, corrections for zero-field many-body, 17: 4526

**TIN FOILS**
superconducting transition temperatures of silver and cobalt coated, 17: 5139

**TIN ISOTOPES**
energy levels of, theory of low-lying vibration, 17: 5365
helium-3 elastic scattering by, optical model for, 17: 5364
mass measurement of, absolute, 17: 5333
neutron separation energies, 17: 5333

**TIN OXIDE FILMS**
radiation effects on conductivity of, on glass, 17: 5019
radiation effects on, on glass, 17: 5020

**TIN SYSTEMS**
Pb–Te–Sn, electric and thermal properties, 17: 4886(R) (AD-275610)

**TIN, TETRAPHENYL-**
luminescence quenching effects on diphenylanthracene and p-terphenyl in benzene and cyclohexane solutions, 17: 4564

**TIPPIPAH SPRING QUADRANGLE (NEV.)**
geologic map of, 17: 4737

**TISSUES**
radiation dosimetry near interface of soft, and bone, 17: 4850
transplantation of, in therapy of radioinduced mouse chimeras, 17: 4432

**TITANIUM**
alloying effects on aluminum–niobium alloy oxidation, 17: 4902(R) (DRI-2061)
casting, 17: 4910(R) (MAB-139-M(C7))
determination using 7,8-dyhydroxy-4-methylcoumarin, 17: 4464

**TITANIUM ALLOYS**
chemical properties and structure of pyrophorous, 17: 4935(T) (AEC-tr-5545)

- Al–Nb–Ti, oxidation resistance, effect of metallic additions on, 17: 4903(R) (DRI-2075)
- Be–Cu–Ti, properties as brazing alloy, 17: 4912(R) (ORNL-TM-413)
- Be–Ti–Zr, properties as brazing alloy, 17: 4912(R) (ORNL-TM-413)
- Nb-Ta-Ti-V, fabrication and properties, 17: 4924(R) (ARF-B231-7)

**TITANIUM CHLORIDES**
- polarizability of liquid, corrections for zero-field many-body, 17: 4526

**TITANIUM ISOTOPES Ti-48**
- helium nucleus reactions (helium-3,t), spectra from, 17: 5391

**TITANIUM ISOTOPES Ti-50**
- energy levels, 17: 5385
- energy levels of, effects of nucleon interactions on, 17: 5366

**TITANIUM OXIDE FILMS**
- radiation effects on, on glass, 17: 5020

**TITANIUM OXIDES**
- PbO–$TiO_2$–$ZrO_2$, phase studies, 17: 4963

**TOCOPHEROLS**
- protective effects against radiation lethality in mice, 17: 4442

**TOLUENE, FLUORO-**
- fluorine-18 retention by, in solutions, 17: 4603

**TOPOPAH SPRING QUADRANGLE (NEV.)**
- geologic map of northwest, 17: 4741

**TORI**
- plasma stability in, numerical studies of, 17: 5440 (TID-13633)

**TOXICOLOGY**
- review of inorganic, 17: 4388

**TRACER TECHNIQUES**
- industrial uses of, review, 17: 5064

**TRACER TECHNIQUES (CHEMICAL ENGINEERING)**
- use for detecting leaks in buried oil pipelines, 17: 4768(P)

**TRACER TECHNIQUES (CHEMISTRY)**
- measurement of diffusion coefficients by, 17: 4549

**TRANSDUCERS**
- determination of yield of explosively loaded metals with quartz, 17: 4949

**TRANSISTORS**
- testing and properties for avalanche-mode operation, 17: 4651

**TRIOXANES**
- radioinduced polymerization of, in solid state, mechanisms of, 17: 4579 (TID-7643(p.150-77))

**TRITIUM**
- deuteron reactions (d,n) in Cockcroft-Walton Accelerator, alpha and neutron yields from, 17: 5412 (NDL-TM-6)
- monitoring at Savannah River Plant, 17: 4455 (DP-771)
- movement in ground water at Savannah River Plant, 17: 4700
- occurrence in meteorites and recovered satellites, 17: 4708
- production control at Savannah River, 17: 4455 (DP-771)
- separation from deuterium and hydrogen by gas chromatography, 17: 4875
- uses of fission product, 17: 4455 (DP-771)
- yield from thermal neutron fission of uranium-235, 17: 5337

**TRITONS**
- distortion of, in hypernucleus $_{\Lambda}H^4$, 17: 5332
- production in helium-3 reactions, on medium-weight nuclei, 17: 5391

**TROPOSPHERE**
- mass and radioactivity transport from stratosphere to, 17: 4699

**TUBES**
- collapse of long hollow cylinder of silicon carbide surrounded by a concentric cylinder of uranium, 17: 4958
- convection flow in vertical, heat transfer and pressure drop in, 17: 4673
- expansion of circular cylindrical, under dynamic loads, 17: 4642(T) (UCRL-Trans-876(L))
- fluid flow by forced convection in, with variable viscosity, 17: 4675
- fluid flow in circular, temperature distribution in laminar, 17: 4665
- heat transfer in, by combined forced convection and thermal radiation, 17: 4671
- heat transfer in, effects of boiling on, 17: 4663(T) (AEC-tr-5539)
- heat transfer in, under laminar slip-flow conditions, 17: 4676
- tensile properties of Zircaloy-4, with oriented hydrides, 17: 4932 (TID-17372)

**TUMORS**
- effects of incorporated chromium-51 on viability of cells of, 17: 4410
- growth of transplanted, in mice, effects of feeding irradiated coliform bacilli on, 17: 4408
- induced in rats by blood of irradiated animals, 17: 4409
- mortality effects of malignant, on Nagasaki atomic bomb survivors, 17: 4404
- radiosensitivity of, effects of 5-chlorodeoxyuridine on, 17: 4411
- radiotherapy of, effects on bones, muscles, and skin in children, 17: 4400

**TUNGSTEN**
- casting, 17: 4910(R) (MAB-139-M(C7))
- cesium ion reactions on, negative-ion yields from, 17: 5087
- crystal lattice parameters of, determination of, 17: 4928 (GAT-T-998)
- determination of traces in marine organisms, activation, 17: 4468
- properties of, for use in thermionic reactors, 17: 5577 (GA-3523)
- sorption of cesium from, field, 17: 4525
- spinning, 17: 4916

**TUNGSTEN ALLOYS**
- corrosion of, bibliography on, 17: 4904 (LAMS-2779)
- spinning, 17: 4916

**TUNGSTEN CARBIDES**
- neutron lifetimes in, 17: 5299 (LA-2743)

**TUNGSTEN COATINGS**
- deposition of, on refractory metals, 17: 4964

**TUNGSTEN ISOTOPES W-179**
- gamma magnetic transitions in, orbit-flip effects on, 17: 5350

**TUNGSTEN ISOTOPES W-181**
- gamma magnetic transitions in, orbit-flip effects on, 17: 5350

**TUNGSTEN ISOTOPES W-182**
- half life of the 152-kev transition, 17: 5394

**TUNGSTEN ISOTOPES W-186**
- proton reactions (p,xp) at 100 to 400 Mev, cross sections for, 17: 5323 (NYO-8921)

**TUNGSTEN SYSTEMS**
- Si-W, dissociation pressures, 17: 4933 (WADD-TR-60-463(Pt.II))

**TURBINES**
- control of steam, 17: 4686(P)

## U

**ULTRASONICS**
- wave propagation in a plasma, 17: 5490

**UNDERGROUND EXPLOSIONS**
- detection of nuclear, review of, 17: 5061
- generation of horizontally polarized shear waves by, 17: 5107

**UNDERWATER EXPLOSIONS**
- detection of nuclear, review of, 17: 5061
- nuclear debris from, properties in sea water, 17: 4750

**UNITED STATES**
- salt deposits, geological summary, 17: 4705

**URANINITES**
- age estimation of Yugoslavia, using lead isotopes, 17: 4709

**URANIUM**
- analytical chemistry, literature review, 17: 4485
- collapse of long hollow cylinder of silicon carbide surrounded by a concentric cylinder of, 17: 4958
- content in granodiorite, effects of chemical weathering on, 17: 4697
- content in phosphate rock, 17: 4695
- determination in aluminum alloy (214X) matrix by x-ray fluorescence, 17: 4459 (GAT-T-1053)
- determination in air, design of apparatus for, 17: 4811
- determination in herbage, colorimetric, 17: 4472
- determination in milk, colorimetric, 17: 4473
- determination of hexavalent, spectrophotometric method using Monochrome Black Blue G and Diamond Black PBB, 17: 4477
- determination of tetravalent, spectrophotometric method using Solochrome Fast Grey R.A.S., 17: 4476
- distribution in Cretaceous Mancos shale, 17: 4696
- electric mobility in bismuth (liquid) at 500°C, 17: 4946
- mining of, radiation hygiene in, 17: 4747
- neutron lifetimes in, 17: 5299 (LA-2743)
- oxidation in air, particulate generation during, 17: 4491 (HW-SA-2641)
- removal of irradiated, from Ispra-1 Reactor, 17: 4993
- separation by electrophoresis on zirconium phosphate paper, 17: 4467

separation from bismuth and thorium by anion exchange, 17: 4478
separation from ore, 17: 4623(P)
separation from uranium wastes, 17: 4632
shipping container for enriched, testing of, 17: 4745 (Y-KB-22)
solvent extraction of, from mineral acids in bis(di-n-hexylphosphinyl) methane, 17: 4445 (IS-500(Sect.C))
thermodynamic properties of gaseous, at 300 to 5000°K, 17: 4521
**URANIUM (Al CLAD)**
diffusion of, effects of nickel barriers on, 17: 4926 (EUR-17.f)
**URANIUM (STAINLESS STEEL CLAD)**
radioinduced swelling of, 17: 5004
**URANIUM ALLOYS**
Al–Ni–U, radiation effects on, at high temperatures, 17: 5023
Cr–U, electric conductivity of, 17: 4446 (IS-500(Sect.E))
Pu-U, lattice constants of alpha, 17: 4923 (ANL-6460)
Pu–U, phase diagram, 17: 4984
Re–U, phase studies, 17: 4447 (IS-500(Sect.M))
U-Zr, surface tension and viscosity, 17: 4933 (WADD-TR-60-463(Pt.II))
**URANIUM CARBIDES**
diffusion of xenon in, 17: 4927(R) (EURAEC-312)
formation, equilibria, 17: 4518
radiation effects on, mechanism of, 17: 4900
radiation effects on, in graphite matrix, 17: 5041(R) (ORNL-3364 (p.151-200))
radiation effects on pyrolytic-carbon-coated, 17: 5041(R) (ORNL-3364 (p.151-200))
structure of $UC_2$ and $U_2C_3$, 17: 4503
ThC–UC, properties on reactor fuel, 17: 4888 (GA-3109)
UC-ZrC, properties of, for use in thermionic reactors, 17: 5577 (GA-3523)
**URANIUM COMPLEXES**
with glutamic acid, polarography of, 17: 4538
**URANIUM DEPOSITS**
geology of, of Colorado Plateau, 17: 4714
**URANIUM(IV) FLUORIDES**
production from uranium raw material, 17: 4624(P)
**URANIUM(VI) FLUORIDES**
availability of enriched, for use as fuel in nuclear power plants, 17: 5610
use as reactor fuel, 17: 5580 (NP-12239)
**URANIUM GLASS**
fabrication in rods, 17: 4374(R) (MLM-1129)
**URANIUM HYDRIDES**
melting of, at 1005 to 1085°C, 17: 4512
**URANIUM ISOTOPES**
variations of ratio of uranium-234 to uranium-238, use in age estimations, 17: 4718
**URANIUM ISOTOPES U-233**
fission energy of, thermal neutron, 17: 5334
nuclear orientation of, in uranium dioxides, 17: 5056
separation of, from thorium, 17: 4446 (IS-500(Sect.E))
**URANIUM ISOTOPES U-234**
ratio with uranium-238 in nature, 17: 5096
separation from plutonium-238, 17: 4375(R) (MLM-1133)
**URANIUM ISOTOPES U-235**
fission energy of, thermal neutron, 17: 5334
fission of, beta activity of products from, 17: 5407
neutron fission yield of tritium, thermal, 17: 5337
nuclear orientation of, in uranium dioxides, 17: 5056
**URANIUM ISOTOPES U-236**
neutron fission of, neutron yields from thermal, 17: 5351
**URANIUM ISOTOPES U-238**
neutron capture cadmium ratio for, 17: 5373
ratio with uranium-234 in nature, 17: 5096
spontaneous fission half life, 17: 4707
**URANIUM LEACH RESIDUES**
calcining and drying of, systems for, 17: 4630
processing for removal of radium-226, 17: 5653
**URANIUM LEACH SOLUTIONS**
processing for thorium and yttrium recovery, 17: 4637(P)
**URANIUM MINERALS**
age estimation of secondary, in northern Bavaria, 17: 4710
**URANIUM ORES**
uranium separation from, 17: 4623(P)
**URANIUM(IV) OXIDE COMPACTS**
radioinduced melting of, heat rating necessary for central, 17: 4895
sintering, 17: 4889(T,R) (EURAEC-322)
sintering, 17: 4922(P)
$PuO_2$–$UO_2$, sintering, 17: 4922(P)
**URANIUM(IV) OXIDE CRYSTALS**
radiation effects, 17: 5037(R) (ORNL-3364(p.27-56))
**URANIUM(IV) OXIDE POWDERS**
compacting, 17: 4889(T,R) (EURAEC-322)
compaction of, vibratory, 17: 4909 (GEAP-3891)
densification, 17: 4987(P)
granulation of densified, 17: 4987(P)
preparation from uranium trioxide, 17: 4621(T) (EURAEC-346)
sintering, 17: 4621(T) (EURAEC-346)
sintering in steam, 17: 4913
**URANIUM OXIDES**
sintering of non-stoichiometric, 17: 4920(P)
**URANIUM(IV) OXIDES**
diffusion of xenon in, 17: 4927(R) (EURAEC-312)
fission fragment energy spectrum from thin layers of, 17: 5085
fission fragment tracks in, 17: 4974
fission gas release from, in-pile, 17: 4896
fission-gas release from irradiated, 17: 5041(R) (ORNL-3364(p.151-200))
preparation of sols, 17: 4556(P)
processing, from spent reactor fuel, 17: 4628 (NAA-SR-7136)
properties of, effects of oxygen on diffusion and thermal, 17: 4894
radiation effects, 17: 4889(T,R) (EURAEC-322)
radiation effects on metal-clad, 17: 5041(R) (ORNL-3364(p.151-200))
radioinduced melting of, heat rating necessary for central, 17: 4895
reactions with graphite, equilibria, 17: 4518
uranium-233 and -235 nuclear orientation in, 17: 5056
$PuO_2$–$UO_2$, fabrication of, 17: 4898
$PuO_2$–$UO_2$, radiation effects on, 17: 4898
$ThO_2$–$UO_2$, radiation effects, 17: 5041(R) (ORNL-3364(p.151-200))
**URANIUM(VI) OXIDES**
reduction by ammonia, effects of alkali carbonates on, 17: 4622
reduction to uranium dioxide, 17: 4621(T) (EURAEC-346)
**URANIUM POWDERS**
ignition behavior of, 17: 4972
**URANIUM SYSTEMS**
C–U, oxidation protection of reactor fuel elements using, 17: 5590(P)
**URANYL FLUORIDES**
neutron multiplication in fully-enriched, in cylindrical containers, 17: 5198 (HASL-124)
**URANYL IONS**
separation by electrophoresis on zirconium phosphate paper, 17: 4467
**URANYL NITRATES**
$UO_2(NO_3)_2$–$D_2O$, properties as reactor fuel, 17: 5605(P)
**URANYL SULFATES**
reduction in presence of α-hydroxy iso-butyric acid, kinetics of photochemical, 17: 4606
**UREA COMPLEXES**
with cerium, formation, 17: 4544
**UREA, THIO-, COMPLEXES**
with cerium, formation, 17: 4544
**URIDINES, 2'-DEOXY-**
effects of 5-chloro-, on radiosensitivity of tumor cells, 17: 4411

**V**

**VACUUM GAGES**
design, 17: 4802(P)
**VACUUM SYSTEMS**
electric breakdown in, effects of contamination from thermal decomposition of glass, 17: 4640 (TID-15465)
valves for protection of, design of fast-closing large-aperture, 17: 4650
**VACUUM VALVES**
design of fast-closing large-aperture, 17: 4650
**VALVES**
design of control, 17: 4658(P)
**VAN ALLEN RADIATION BELTS**

contribution to radiation dose in space vehicles, 17: 5646
effects on the geomagnetic field, 17: 4704
electron intensity in outer, 17: 5183
flux densities and mirror-point distributions, 17: 5182
intensity changes due to reactor power sources in, 17: 5067
intensity of inner, time variations of, 17: 5186
properties of the outer, 17: 5184
spectra of energetic particles in inner, 17: 5195

**VANADIUM**
alloying effects on aluminum–niobium alloy oxidation, 17: 4902(R) (DRI-2061)
determination of traces in marine organisms, activation, 17: 4468
preparation of high-purity, 17: 4447 (IS-500(Sect.M))

**VANADIUM ALLOYS**
fabrication and properties, 17: 4924(R) (ARF-B231-7)
Nb-Ta-Ti-V, fabrication and properties, 17: 4924(R) (ARF-B231-7)
Th–V, phase diagram, 17: 4936

**VANADIUM ISOTOPES**
helium-3 elastic scattering by, optical model for, 17: 5364

**VANADIUM ISOTOPES V-46**
positron decay, 17: 5325 (PUC-1962-62)

**VANADIUM ISOTOPES V-51**
neutron reactions (n,d) at 14.4 Mev, 17: 5385
proton reactions (p,xp) at 100 to 400 Mev,cross sections for, 17: 5323 (NYO-8921)

**VANADIUM OXIDES**
$SiO_2$–$V_2O_5$, viscosity, 17: 4933 (WADD-TR-60-463(Pt.II))

**VEHICLES**
shock waves from hypersonic, propagation in plasma, 17: 5430 (AD-276418)

**VINYL COMPOUNDS**
radiation effects, 17: 4571 (TID-7643(p.1-16))
radioinduced graft polymerization to textile fibers, 17: 4586 (TID-7643 (p.268-99))
radioinduced polymerization of, in solid state, 17: 4578 (TID-7643(p.136-49))

**VIRUSES**
radiation effects on measle infection and immunity in monkeys, 17: 4401

**VITAMINS**
determination in biological materials by paper chromatography, 17: 4380(R) (UCRL-10479)

## W

**WASPALOY**
creep rate, effects of alternating stress, 17: 4965

**WASTE DISPOSAL**
facilities for aqueous, in Italy, 17: 5649
fission product incorporation in glass, 17: 5650
safety aspects of, in USSR, 17: 4752

**WASTE PROCESSING**
methods for radioactive waste water, review, 17: 5652

**WASTE RECOVERY**
of protactinum and uranium from ethereal sludge, 17: 4632

**WASTE SOLUTIONS**
disposal of, in Italy, 17: 5649
processing by solvent extraction, 17: 4625 (HW-SA-2767)
radioactivity of, apparatus and methods for measuring, 17: 5651

**WATER**
anharmonicity constants of isotopically substituted, 17: 4546(T)
chemistry of, in water-cooled reactors, 17: 4907
determination, review of physical methods, 17: 4465
heat transfer in forced flow of, 17: 4662(T) (AEC-tr-5538)
neutron diffusion parameters of, 17: 5308
neutron scattering at 0.10, 0.15, and 0.25 ev at 22°C, quasi-elastic, 17: 5297 (HW-75147)
radioactivity measurement in waste, apparatus and methods for, 17: 5651
radioactivity measurement in, continuous, 17: 4815
radioactivity measurement in, discontinuous, 17: 4816
radiolysis of, effects of pH on radical yields in, 17: 4614
reactions with carbon dioxide, effects of pressure and temperature on isotopic fractionation in, 17: 4511
separation by solvent extraction using tributyl phosphate–n-hexane, 17: 4634
solvent properties for mercury at 25 to 90°C, activation study, 17: 4451
solvent properties for lithium hydroxide at high temperatures, 17: 4520
spectra at 500 to 600 cm$^{-1}$, effects on centrifugal distortion on infrared, 17: 4771 (NP-12236)
$HNO_3$–TBP–$H_2O$, molecular interactions in, 17: 4446 (IS-500(Sect.E))

**WATER-*d*,**
effects on thermal denaturation of desoxyribonucleic acid, 17: 4389
production by dual-temperature exchange, control of, 17: 4873
solvent properties in chemical reactions, isotope effects on, 17: 5063
$UO_2(NO_3)_2$–$D_2O$, properties as reactor fuel, 17: 5605(P)

**WATER COOLED REACTORS**
description and performance of pressure-tube, 17: 5612
description and prospects of pressurized, 17: 5611
design and technology of, chemical and metallurgical problems in, 17: 4907
design of 300-Mwe, 17: 5579 (NDA-2132-5)
physics of, 17: 5585

**WATER MODERATED REACTORS**
description and performance of pressure-tube, 17: 5612
description and prospects of pressurized, 17: 5611
design and technology of, chemical and metallurgical problems in, 17: 4907
fuel can damage in, detection limits of, 17: 5007
physics of, 17: 5585

**WATER VAPOR**
adsorption on cleaved surfaces of LiF, 17: 4545
analysis of ionized, mass spectrometric, 17: 4457 (GA-3358)

**WELDING**
description of projection, 17: 4915
edge, using an electron beam for, 17: 4921(P)

**WELL LOGGING**
gamma radiation measurement, 17: 4865(P)
scintillation counter design for, 17: 4863(P)

**WHEAT**
analysis for protein fractions in irradiated flour of, electrophoretic, 17: 4766
radiation effects on chemical and physical properties of flour protein of, 17: 4766

**WIND**
measurements in mesodecline over Nevada Test Site, 17: 4701

**WINDSCALE ADVANCED GAS COOLED REACTOR**
fuel costs, effects of coolant selection, 17: 5616

**WOOD**
radioinduced polymerization of monomers impregnated in, 17: 4589 (TID-7643(p.335-44))

## X

**X RADIATION**
book: *Physical Foundations of Radiology*, 17: 4431
dosimetry near interface of soft tissue and bone, 17: 4850
effects in mice and rats, dose-rate dependence of early, 17: 4421
effects on adrenocortical-hypophyseo function, 17: 4406
effects on aging in mice, 17: 4418
effects on calcium-45 storage by bones in mice, 17: 4425
effects on fibrous proteins, electron spin resonance study of, 17: 4429
effects on function and structure of villus epithelial cells in mice, 17: 4420
effects on hematopoietic system in guinea pigs, mice, and rats, single whole-body, 17: 4398
effects on hematopoietic system in rabbits, 17: 4428
effects on hemoglobin in rabbits from abdominal skin exposure, 17: 4426
effects on liver glycogen metabolism, head exposure, 17: 4393
effects on luminescence in alkali halide crystals, 17: 5112
effects on lymphocytosis and whole-body immunity by hypophysis exposure, 17: 4407
effects on pneumococcal infection in mice, time factors in, 17: 4413
effects on reproduction in *Tribolium castaneum* Herbst, 17: 4417
effects on sodium transport across cell membranes in erythrocytes, 17: 4412

- emission in solar flare, 17: 5091
- interactions in detectors, 17: 4820
- ionization of gases by, electron conductivity in, 17: 5072
- leukogenic effects on mice treated with cortisone, 17: 4396
- protection against, development of system for, 17: 4748
- scattering by atoms, dispersion corrections for, 17: 5045 (TID-14794)
- scattering by lead, Kohn anomaly measurement by, 17: 5146

**X-RAY-ABSORPTION ANALYSIS**
- equipment for, design of high-pressure, 17: 4848
- use for determination of cobalt in complex mixtures, 17: 4462

**X-RAY CAMERAS**
- development of Lang, 17: 5037(R) (ORNL-3364(p.27-56))

**X-RAY EQUIPMENT**
- design of cone, 17: 4800(P)
- design of high-pressure, 17: 4848

**X-RAY MONOCHROMATORS**
- parameters of, wavelength distributions, 17: 4779
- theory of, 17: 4778

**X-RAY SPECTROMETERS**
- design for fluorescence analysis, 17: 4799(P)
- design of scanning mechanism for satellite-borne, 17: 4808 (NASA-TN-D-1097)
- design of total-absorption scintillation, 17: 4854

**XENON**
- diffusion in thorium and uranium dioxides and uranium carbide, 17: 4927(R) (EURAEC-312)
- electric discharge in, negative radiation temperature, 17: 5461
- polarizability of liquid, corrections for zero-field many-body, 17: 4526
- purification of, by low-temperature distillation, 17: 4374(R) (MLM-1129)
- radiolysis effects on labeled and unlabeled propane, 17: 4601
- reactions with carbon monoxide and nitrogen at high pressure, spectra of, 17: 4527
- reactions with graphitized carbon black at 2700°C, third order gas-surface, 17: 4534

**XENON ISOTOPES**
- helium-3 elastic scattering by, optical model for, 17: 5364

**XENON ISOTOPES Xe-127**
- occurrence in recovered satellites, 17: 4708

**XENON ISOTOPES Xe-129**
- abundance in atmosphere, 17: 5172
- abundance in the atmosphere, 17: 5171

**XENON ISOTOPES Xe-131**
- energy levels of, lifetimes of, 17: 5335

**XENON ISOTOPES Xe-132**
- energy levels and gamma spectra of, 17: 5371

**XENON ISOTOPES Xe-133**
- diffusion from uranium dioxide compacts, 17: 4889(T,R) (EURAEC-322)
- diffusion from uranium dioxide, in-pile, 17: 4896

**XENON ISOTOPES Xe-135**
- diffusion from uranium dioxide, in-pile, 17: 4896

**XENON ISOTOPES Xe-136**
- abundance in atmosphere, 17: 5172

**XYLENE**
- fluorescence quenching in cyclohexane solution of, by oxygen, 17: 4566
- luminescence quenching in benzene solution, effects of aromatic halides on, 17: 4563

**XYLOSE**
- spectra of trimethylsilylation products of, 17: 4561(R) (UCRL-10350)

## Y

**YANKEE POWER REACTOR**
- description, 17: 5611

**YTTERBIUM**
- enthalpy and related thermodynamic properties at 0 to 1100°C, 17: 4929 (IS-327)
- separation by electrophoresis on zirconium phosphate paper, 17: 4467
- spectra in barium, calcium, and strontium fluorides, absorption and luminescence, 17: 4547(T)

**YTTERBIUM ACETATES**
- polarography of, in anhydrous ethylenediamine, 17: 4486

**YTTERBIUM ISOTOPES Yb-177**
- gamma magnetic transitions in, orbit-flip effects on, 17: 5350

**YTTRIUM**
- enthalpy and related thermodynamic properties at 0 to 1675°C, 17: 4929 (IS-327)
- oxidation of, in air at 500 to 1400°C, 17: 4447 (IS-500(Sect.M))
- preparation of high-purity, 17: 4447 (IS-500(Sect.M))
- separation from uranium leach waste liquors, 17: 4637(P)
- vapor pressure, 17: 4515

**YTTRIUM ALLOYS**
- Gd–Y, phase studies, 17: 4981
- La–Y, phase studies, 17: 4981
- Y–Zn, phase studies, 17: 4447 (IS-500(Sect.M))
- Y–Zr, surface tension of liquid, 17: 4943

**YTTRIUM CARBONATES**
- decomposition of, mechanism of thermal, 17: 4553

**YTTRIUM ISOTOPES Y-90**
- beta depth-dose measurement in lucite, 17: 4851

**YTTRIUM OXALATES**
- decomposition of, mechanism of thermal, 17: 4553

**YTTRIUM OXIDES**
- melting point, effects of oxygen content, 17: 4447 (IS-500(Sect.M))

**YTTRIUM SILICATES**
- $Ca_2SiO_4$–$Y_4(SiO_4)_3$, phase studies and structure, 17: 4548

**YUCCA FLAT QUADRANGLE (NEV.)**
- geologic map of, 17: 4727

**YUCCA LAKE QUADRANGLE (NEV.)**
- geologic map of, 17: 4733

**YUGOSLAVIA**
- age estimation of uraninites using lead isotopes, 17: 4709

## Z

**ZINC**
- determination in sea water, activation, 17: 4469
- separation by electrophoresis on zirconium phosphate paper, 17: 4467
- separation from plutonium exchange, 17: 4629
- sputtering of, by argon ions, 17: 5038(R) (ORNL-3364(p.57-84))
- viscosity of, relation of atomic mobility to, 17: 4945

**ZINC ALLOYS**
- Pu–Zn, phase diagram, 17: 4984
- Y–Zn, phase studies, 17: 4447 (IS-500(Sect.M))

**ZINC CHLORIDES**
- spectra in argon, krypton, and xenon matrices, infrared, 17: 4497 (UCRL-10451)

**ZINC ISOTOPES Zn-64**
- alpha scattering at 43 Mev, distributions from, 17: 5358

**ZINC ISOTOPES Zn-68**
- alpha scattering at 43 Mev, distributions from, 17: 5358
- proton reactions (p,xp) at 100 to 400 Mev, cross sections for, 17: 5323 (NYO-8921)

**ZINC OXIDE FILMS**
- radiation effects on, on glass, 17: 5020

**ZINC PERCHLORATES**
- reactions with dioxane, structure of addition compound formed in, 17: 4452

**ZINC SELENIDE CRYSTALS**
- radiation effects on electric conductivity of, gamma, 17: 5005

**ZINC SULFIDE CRYSTALS**
- radiation effects, 17: 5039(R) (ORNL-3364(p.85-124))
- radiation effects on electric conductivity of, gamma, 17: 5005

**ZINC SULFIDES**
- deposition of, in thin layers, for alpha detection by scintillation, 17: 4847

**ZINC TELLURIDES**
- radiation effects on electric conductivity of, gamma, 17: 5005

**ZIRCALOY-2**
- brazing to stainless steel, 17: 4889(T,R) (EURAEC-322)
- inspection of tubes of, eddy current technique for, 17: 4689
- stress-rupture in-pile testing, 17: 5040(R) (ORNL-3364(p.125-50))

**ZIRCALOY-4**
- tensile properties of tubing of, with oriented hydrides, 17: 4932 (TID-17372)

**ZIRCONIUM**
- alloying effects on aluminum–niobium alloy oxidation, 17: 4902(R) (DRI-2061)
- analysis of very pure, for impurities by radioactivation, 17: 4480
- determination, 17: 4633
- determination in natural materials, 17: 4474
- electric mobility in bismuth (liquid) at 500°C, 17: 4946
- movement in ground water at Savannah River Plant, 17: 4700
- purification by Van Arkel method, 17: 4890
- separation of, from hafnium by anion exchange, 17: 4633

**ZIRCONIUM ALLOYS**
- chemical properties and structure of pyrophorous, 17: 4935(T) (AEC-tr-5545)
- Be–Ti–Zr, properties as brazing alloy, 17: 4912(R) (ORNL-TM-413)
- Co–Zr, phase studies, 17: 4447 (IS-500(Sect.M))
- Cu–Zr, effects of arsenic on electric conductivity of, 17: 4938
- Dy–Zr, surface tension of liquid, 17: 4943
- Er–Zr, surface tension of liquid, 17: 4943
- Ho–Zr, surface tension of liquid, 17: 4943
- Nb–Ta–Zr, superconductivity, 17: 4886(R) (AD-275610)
- Nb–Zr, corrosion by potassium, 17: 4905(R) (NP-12334)
- Nb-Zr, performance in superconducting solenoids, 17: 4781
- Nb–Zr, stress-rupture in-pile testing, 17: 5040(R) (ORNL-3364(p.125-50))
- Nb–Zr, superconductivity of, effects of magnetic-field orientation on, 17: 5037(R) (ORNL-3364(p.27-56))
- Nb–Zr, tensile properties at 4.2, 77, and 300°K, 17: 5037(R) (ORNL-3364(p.27-56))
- Nd–Zr, surface tension of liquid, 17: 4943
- U-Zr, surface tension and viscosity, 17: 4933 (WADD-TR-60-463(Pt.II))
- Y-Zr, surface tension of liquid, 17: 4943

**ZIRCONIUM BROMIDES**
- heat of formation and thermodynamic properties, 17: 4501

**ZIRCONIUM CARBIDES**
- UC-ZrC, properties of, for use in thermionic reactors, 17: 5577 (GA-3523)

**ZIRCONIUM CHLORIDES**
- heat of formation and thermodynamic properties, 17: 4501
- preparation by sublimation, 17: 4557(P)
- production, 17: 4555(P)

**ZIRCONIUM ELECTRODES**
- electric arcs between, infrared spectra of, 17: 4793

**ZIRCONIUM IODIDES**
- heat of formation and thermodynamic properties, 17: 4501

**ZIRCONIUM ISOTOPES**
- energy levels of, theory of low-lying vibrational, 17: 5365

**ZIRCONIUM ISOTOPES Zr-95**
- determination by coincidence counting, 17: 4845

**ZIRCONIUM OXIDES**
- crystal structure of tetragonal, 17: 4504
- phase transformation, effects of pressure and temperature on monoclinic-tetragonal, 17: 4519
- radiation effects on catalytic action in thermal dissociation of ethanol, 17: 4569 (NP-12250)
- sorptive properties for hydrogen, 17: 4500(T) (AEC-tr-5529)
- sorptive properties for electrolytes, effects of previous hydrogen adsorption on, 17: 4500(T) (AEC-tr-5529)
- PbO–$TiO_2$–$ZrO_2$, phase studies, 17: 4963

**ZIRCONIUM PHOSPHATES**
- ion exchange properties in electrophoretic separation of inorganic ions, 17: 4467

**ZIRCONIUM SYSTEMS**
- H–Zr, phase studies of, 17: 4939
- H–Zr, preparation of crack-free specimens of, 17: 4940
- H–Zr, thermophysical properties of, 17: 4940

**ZIRCONS**
- analysis of natural, for impurities, 17: 4716
- radiation effects, 17: 5041(R) (ORNL-3364(p.151-200))
- thermonuclear activities in, 17: 4716

# REPORT NUMBER INDEX

All reports, translations, and patents abstracted in this issue are included in this index. Each item is listed by report number; this is followed by the abstract number and a brief notation regarding public availability. The index entries show, when known, which reports are on file in the depository libraries, which reports have been published in open-literature journals (journal citation given), and which reports can be purchased (source and price). Whenever a report is identified by more than one number, cross references from secondary to primary report numbers are cited.

The report number codes apply to AEC reports unless designated otherwise. Non-AEC reports are identified by parenthetical notes after the report codes; e.g., (non-AEC), (British), (Canadian), (French). The note (Misc.) identifies those codes used for both USAEC and non-AEC reports. The report numbers for the non-AEC reports in these series are marked with an asterisk (*). Patents are listed under the heading "PATENTS"; the country of origin is included in parentheses.

A comprehensive listing of both AEC and non-AEC report codes is contained in TID-85(2nd Rev.), *Report Number Series Used by the Technical Information Service in Cataloging Reports*. March 1960, $2.75 (OTS), and supplement, August 1960, $0.50 (OTS).

## Public Availability of USAEC Reports

All USAEC reports abstracted in *NSA* are available to the public through one or more of the following sources:

(1) Depository libraries in the United States, in other countries, and in international agencies. A list of these depositories, many of which have facilities for preparing photocopy for sale, appears on the inside covers of each issue of *NSA*.

(2) Scientific and technical journals or other publications.

(3) Microcard Editions, Inc., in Microcard form. Orders and inquiries should be sent to: Accounting and Shipping Department, West Salem, Wisconsin.

(4) Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., for sale as full-size printed copy, photostat or facsimile (Xerox), and microfilm.

(5) Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for sale as full-size printed copy.

## Public Availability of Non-AEC Reports

*U. S. Reports.* Many reports of U. S. Government agencies other than the AEC can be obtained by the public in the same manner as AEC reports. The availability of these reports is given when known. If availability is not shown, inquiries should be directed to the Office of Technical Services. Inquiries concerning "NP" reports should be by title and author rather than by NP number.

*Non-U. S. Reports.* Many reports of atomic energy establishments of other countries are placed in the depository libraries in the United States, where they are available for public use. Other reports appear in the journal literature. Some British reports are sold by the British Information Service, 45 Rockefeller Plaza, New York 20, N. Y. Some Canadian reports are sold by Atomic Energy of Canada Ltd., Chalk River, Ontario, Canada. This index identifies any type of public availability known to the USAEC.

## Abbreviations Used in Availability Column

| | |
|---|---|
| AECL | For sale by Atomic Energy of Canada Ltd., Chalk River, Ontario, Canada. |
| BIS | For sale by the British Information Service, 45 Rockefeller Plaza, New York 20, N. Y. |
| Dep. | AEC reports: Full-size copy is on deposit in the depository libraries both in and outside the United States. These reports are also for sale by Microcard Editions, Inc., Accounting and Shipping Department, West Salem, Wisconsin.<br>Non-AEC reports: Full-size copy on deposit in the depository libraries in the United States only. |
| Dep.(mc) | Same as for Dep., except copy is in Microcard form. |
| DSIR | For sale by the Department of Scientific and Industrial Research, Lending Library Unit, 20 Chester Terrace, London, N. W. 1, England. |
| DTI Extension | Available from the U. S. Atomic Energy Commission, Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee. |
| GPO | For sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C. |
| HMSO | Her Majesty's Stationery Office, London. |
| IAEA | Available from the International Atomic Energy Agency. |
| JCL | For sale by the Special Libraries Association Translation Center, John Crerar Library, 86 E. Randolph Street, Chicago 1, Illinois. |
| NRC | For sale by the National Research Council of Canada, Ottawa, Ontario, Canada. |
| OTS | For sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C. |
| USGS | Available free-of-charge from the U. S. Geological Survey, Washington 25, D. C. |

(The symbols "ph," "mf," and "fs" are used to designate that copy is available only in photostat, microfilm, or facsimile (Xerox) form.)

| Report No. | Abstract No. | Availability |
|---|---|---|
| **AD–** | **(Misc.)** | |
| 273492* | 17-5433 | See D1-82-0150 |
| 273497* | 17-5030 | See AFOSR-2114 |
| 273950* | 17-5027 | $2.60(OTS) |
| 273973* | 17-5437 | See GCA-TR-62-8-A |
| 274055* | 17-5531 | See AFCRL-62-281 |
| 274083* | 17-5530 | See AFCRL-62-247 |
| 274164 | 17-4638 | $5.60(OTS) |
| 274182* | 17-5043 | See RM-3058-NASA |
| 274214* | 17-5042 | See RADC-TDR-62-67 |
| 274320* | 17-4807 | See MITNE-8 |
| 274336* | 17-5028 | See AFCRL-62-423 |
| 274553* | 17-5031 | See AFOSR-2535 |
| 274644* | 17-5639 | See DCAS-TDR-62-32 |
| 274693* | 17-5434 | See DCAS-TDR-62-12 |
| 274699* | 17-5435 | See DCAS-TDR-62-45 |
| 274758* | 17-5431 | See AFCRL-62-185 |
| 274799* | 17-5644 | See ZPh-084 |
| 274971* | 17-4885 | $2.60(OTS) |
| 275052* | 17-5638 | See AFCRL-62-148 |
| 275256* | 17-5047 | $14.50(OTS) |
| 275288* | 17-5429 | $2.60(OTS) |
| 275490* | 17-5443 | See WADD-TR-60-676(Pt.II) |
| 275512* | 17-5439 | See PIBMRI-987-62 |
| 275547* | 17-5163 | See ARL-TDR-62-2 |
| 275610* | 17-4886 | $12.50(OTS) |
| 275908* | 17-5637 | |
| 276098* | 17-5436 | See DCAS-TDR-62-79 |
| 276141* | 17-4443 | See AFOSR-2542 |
| 276418* | 17-5430 | |
| 276508* | 17-5179 | See AFCRL-62-453 |
| 276844* | 17-5321 | See BRL-Memo-1392 |
| 276931* | 17-5029 | See AFCRL-62-623 |
| 287897* | 17-4771 | See NP-12236 |
| 288126* | 17-5412 | See NDL-TM-6 |
| 288821* | 17-5044 | See RM-3391-PR |
| 289094* | 17-5300 | See NRL-5851 |
| 290275* | 17-4931 | See NP-12306 |
| 291896* | 17-4911 | See NMI-9700.3 |
| 292079* | 17-4457 | See GA-3358 |
| 292244* | 17-4924 | See ARF-B231-7 |
| **AE–** | **(Swedish)** | |
| 81 | 17-5320 | Dep.(mc) |
| **AEC-tr–** | | |
| 5526 | 17-4871 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| 5527 | 17-4872 | Dep.(mc); $3.60(fs), $1.31(mf) JCL |
| 5529 | 17-4500 | Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS |
| 5534 | 17-4934 | Dep.(mc); $2.60(fs), $0.83(mf) JCL |
| 5538 | 17-4662 | Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS |
| 5539 | 17-4663 | Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS |
| 5540 | 17-4810 | Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS |
| 5545 | 17-4935 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| **AERE-R–** | **(British)** | |
| 3178 | 17-5650 | J. Nucl. Energy, Pt. A and B, 16: 405-21 (1962) |
| 3969 | 17-5199 | Dep.; $0.42(BIS); 3s. (HMSO) |
| 4073 | 17-5012 | Phil. Mag. (8) 7: 1721-9(1962) |
| **Aero-Chem(TN)–** | **(Non-AEC)** | |
| 41 | 17-5641 | See NP-12264 |
| **AFCRL–** | **(Non-AEC)** | |
| 62-1 | 17-4807 | See MITNE-8 |
| 62-148 | 17-5638 | $10.50(OTS) |
| 62-149 | 17-4885 | See AD-274971 |
| 62-185 | 17-5431 | $11.00(OTS) |
| 62-247 | 17-5530 | $2.60(OTS) |
| 62-281 | 17-5531 | $8.60(OTS) |
| 62-421 | 17-5439 | See PIBMRI-987-62 |
| 62-423 | 17-5028 | $3.60(OTS) |
| 62-453 | 17-5179 | $2.60(OTS) |
| 62-623 | 17-5029 | |
| **AFESD-TDR–** | **(Non-AEC)** | |
| 62-71 | 17-5027 | See AD-273950 |
| **AFOSR–** | **(Misc.)** | |
| 2114* | 17-5030 | $2.60(OTS) |
| 2535* | 17-5031 | $3.60(OTS) |
| 2542* | 17-4443 | $6.60(OTS) |
| **AID-REPORT–** | **(Non-AEC)** | |
| 62-172 | 17-5580 | See NP-12239 |
| **ANL–** | | |
| 6460 | 17-4923 | Dep.; $1.00(OTS) |
| **ANL-FGF–** | | |
| 378 | 17-4687 | Dep.(mc); $2.60(fs), $1.04(mf) OTS |
| 392 | 17-5023 | To be published in TID-7642, Proceedings of the Research Reactors Fuel Element Conference held in Gatlinburg, Tenn., Sept. 17–19, 1962 |
| 393 | 17-4887 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| **ARF–** | **(Misc.)** | |
| B231-7* | 17-4924 | $2.60(OTS) |
| **ARL–** | **(Non-AEC)** | |
| 62-406 | 17-4804 | OTS |
| **ARL-TDR–** | **(Non-AEC)** | |
| 62-2 | 17-5163 | $6.60(OTS) |
| **AWRE-O–** | **(British)** | |
| 14/62 | 17-5432 | Dep.(mc); $1.60(fs), $0.85(mf) JCL or OTS |
| **BLG–** | **(Belgian)** | |
| 119 | 17-5574 | Dep.(mc) |
| 123 | 17-5032 | Dep.(mc) |
| **BMI–** | **(Misc.)** | |
| 1598 | 17-5575 | Dep.; $3.00(OTS) |
| **BNL–** | | |
| 5704 | 17-5308 | Nucl. Sci. Eng. 14: 224-9(1962) |
| 5985 | 17-5576 | $1.60(fs), $0.80(mf) OTS |
| 5987 | 17-5293 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 6054 | 17-5373 | Nucl. Sci. Eng. 14: 316-17(1962) |
| 6071 | 17-4568 | Tetrahedron Letters, No. 11, 457-60(1962) |
| 6077 | 17-4420 | Radiation Res. 17: 914-31(1962) |
| 6241 | 17-4421 | Radiology 79: 1008-14(1962) |
| 6470 | 17-5411 | To be published in NAS-NS-3107, Proceedings of the Symposium on Applications of Computers to Nuclear and Radiochemistry, held in Gatlinburg, Tenn., Oct. 18–19, 1962 |
| **BRL-Memo–** | **(Misc.)** | |
| 1392* | 17-5321 | $1.60(OTS) |
| 1432* | 17-5294 | |
| **CEA–** | **(French)** | |
| 2156 | 17-5295 | Dep.(mc) |
| 2170 | 17-5319 | p.219-23 of "Pile Neutron Research in Physics." Vienna, International Atomic Energy Agency, 1962 |
| **CNEN–** | **(Italian)** | |

| Report No. | Abstract No. | Availability |
|---|---|---|
| 141 | 17-4877 | Dep.(mc) |
| **CUA-NE–** | | |
| 25 | 17-4660 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **CVNA–** | **(Misc.)** | |
| 156 | 17-5606 | Dep.(mc); $6.60(fs), $2.27(mf) OTS |
| **D–** | **(Misc.)** | |
| 1-82-0150* | 17-5433 | $1.60(OTS) |
| **DASA–** | **(Misc.)** | |
| 1329* | 17-4457 | See GA-3358 |
| **DC–** | **(Misc.)** | |
| 60-2-80 | 17-4805 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **DCAS-TDR–** | **(Non-AEC)** | |
| 62-12 | 17-5434 | Phys. Fluids, 5: 1590-6(1962) |
| 62-32 | 17-5639 | $3.60(OTS) |
| 62-45 | 17-5435 | $1.60(OTS) |
| 62-79 | 17-5436 | $2.60(OTS) |
| **DP–** | | |
| 771 | 17-4455 | Dep.; $0.50(OTS) |
| 772 | 17-4456 | Dep.; $0.50(OTS) |
| **DRI–** | **(Misc.)** | |
| 2061 | 17-4902 | Dep.(mc); $4.60(fs), $1.55(mf) OTS |
| 2065 | 17-4925 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 2075 | 17-4903 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **DUBNA REPORTS** | | **(Russian)** |
| See JINR (Russian) | | |
| **DXRL–** | **(New Zealand)** | |
| F5 | 17-4690 | Dep. |
| **EANDC–** | **(Misc.)** | |
| 22L* | 17-5296 | Dep.(mc) |
| **EFINS–** | **(Misc.)** | |
| 62-32 | 17-5563 | Phys. Rev. 128: 2906-15(1962) |
| 62-33 | 17-5246 | Phys. Rev. 128: 2808-9(1962) |
| 62-36 | 17-5247 | Phys. Rev. 128: 2810-24(1962) |
| **ER–** | **(Misc.)** | |
| 5098* | 17-5642 | See NP-12270 |
| **EUR–** | **(Belgian)** | |
| 17.f | 17-4926 | Dep.(mc) |
| **EURAEC–** | | |
| 166 | 17-5579 | See NDA-2132-5 |
| 312 | 17-4927 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 322 | 17-4889 | Dep.(mc); $8.10(fs), $2.63(mf) OTS |
| 346 | 17-4621 | Dep.(mc); $2.60(fs), $0.95(mf) OTS |
| 415 | 17-4774 | Dep.(mc); $2.60(fs), $0.95(mf) OTS |
| **GA–** | **(Misc.)** | |
| 2345 | 17-4980 | Trans. Am. Soc. Metals 55: 45-50(1962) |
| 2356 | 17-5486 | Phys. Fluids 5: 1435-46(1962) |
| 2647 Rev. | 17-5496 | Phys. Fluids 5: 1507-13(1962) |
| 2662 | 17-4483 | p.72-77 of "1961 International Conference on Modern Trends in Activation Analysis, A. & M. College of Texas, College Station, Texas, Dec. 15–16, 1961" |
| 3109 | 17-4888 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 3358* | 17-4457 | |
| 3523* | 17-5577 | |
| **GAT-T–** | | |
| 998 | 17-4928 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 1050 | 17-4458 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 1051 | 17-4489 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 1052 | 17-4490 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 1053 | 17-4459 | Dep.(mc); $2.60(fs), $1.01(mf) OTS |
| **GCA-TR–** | **(Non-AEC)** | |
| 62-8-A | 17-5437 | $2.60(OTS) |
| **GEAP–** | **(Misc.)** | |
| 3860 | 17-5607 | Dep.; $2.00(OTS) |
| 3891 | 17-4909 | Dep.; $0.75(OTS) |
| 4082 | 17-4460 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **HASL–** | | |
| 124 | 17-5198 | $0.75(OTS) |
| **HPR–** | **(Norwegian)** | |
| 27 | 17-5608 | Dep.(mc) |
| **HW–** | | |
| 70230 | 17-5033 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 72770 | 17-4840 | Nucl. Instr. Methods 17: 140-4(1962) |
| 75147 | 17-5297 | Dep.; $0.50(OTS) |
| **HW-SA–** | | |
| 2191 | 17-4806 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 2368 | 17-4989 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 2641 | 17-4491 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| 2767 | 17-4625 | Dep.(mc); $2.60(fs), $1.07(mf) OTS |
| 2796 | 17-4559 | Dep.(mc); $2.60(fs), $1.07(mf) OTS |
| 2797 | 17-4626 | Dep.(mc); $3.60(fs), $1.31(mf) OTS |
| 2810 | 17-4627 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 2814 | 17-4990 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **IDO–** | | |
| 11002 | 17-5578 | Dep.(mc); $3.60(fs), $1.22(mf) OTS |
| 14597 | 17-4492 | Dep.; $0.50(OTS) |
| **IS–** | | |
| 299 | 17-5200 | Dep.; $0.75(OTS) |
| 312 | 17-4906 | Chem. Eng. Prog., Symp. Ser. 58: 67-73 (1962) |
| 324 | 17-4506 | Anal. Chim. Acta 27: 101-12(1962) |
| 327 | 17-4929 | Dep.(mc); $3.60(fs), $1.25(mf) OTS |
| 361 | 17-4936 | Am. Soc. Metals 55: 301-6(1962) |
| 393 | 17-4516 | J. Chem. Educ. 39: 167-78(1962) |
| 414 | 17-4981 | Trans. Am. Soc. Metals 55: 483-91(1962) |
| 432 | 17-4769 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 451 | 17-5561 | Phys. Rev. 128: 2887-97(1962) |
| 465 | 17-4537 | J. Chem. Phys. 37: 1895-6(1962) |
| 500 | 17-4444 | Dep.; $4.00(OTS) |
| **JAERI–** | **(Japanese)** | |
| 4023 | 17-4461 | Dep.(mc) |
| **JINR–** | **(Russian)** | |
| P-1051 | 17-5201 | Dep.(mc) |
| **KAPL–** | | |
| 2220 | 17-5298 | Dep.; $1.25(OTS) |
| **KAPL-P–** | | |
| 2198 | 17-4787 | See TID-15345 |
| 2233 | 17-4880 | See TID-13144 |
| **LA–** | | |
| 2743 | 17-5299 | Dep.; $1.75(OTS) |
| **LADC–** | | |

| Report No. | Abstract No. | Availability |
|---|---|---|
| 3089 | 17-4983 | p.152-6 of "The Metal Plutonium." Chicago, Univ. of Chicago, 1961 |
| 3101 | 17-4918 | p.347-64 of "The Metal Plutonium." Chicago, Univ. of Chicago, 1961 |
| 3107 | 17-4908 | p.194-204 of the "The Metal Plutonium." Chicago, Univ. of Chicago, 1961 |
| 4753 | 17-4552 | p.132-8 of "Proceedings of the Fifth Conference on Carbon" [New York], Pergamon Press, 1962 |
| 4832 | 17-4462 | See TID-13406 |
| 4899 | 17-5514 | See TID-13610 |
| 5006 | 17-5440 | See TID-13633 |
| 5013 | 17-4776 | See TID-13632 |
| 5072 | 17-5499 | Phys. Fluids 5: 1531-44(1962) |
| 5073 | 17-4388 | See TID-13972 |
| 5115 | 17-5515 | p.54-61 of "Symposium on Major Effects of Minor Constituents on the Properties of Materials. ASTM Special Tech. Pub. No. 304" |
| 5199 | 17-5065 | See TID-14594 |
| 5216 | 17-5108 | See TID-14800 |
| 5223 | 17-4773 | See TID-14796 |
| 5232 | 17-5045 | See TID-14794 |
| 5352 | 17-4629 | Anal. Chem. 34: 1598-1601(1962) |
| 5353 | 17-4645 | Elec. Eng. 81: 1-5(1962) |
| 5364 | 17-5133 | Phys. Rev. 128: 2479-86(1962) |
| 5406 | 17-4955 | J. Appl. Phys. 33: 3444-50(1962) |
| **LAMS–** | | |
| 2762 | 17-4493 | Dep.; $0.75(OTS) |
| 2779 | 17-4904 | Dep.; $1.00(OTS) |
| **M–** | **(Misc.)** | |
| 6671 | 17-4630 | Chem. Eng. Prog., Symp. Ser. 58: 1-7(1962) |
| **MAB–** | **(Non-AEC)** | |
| 139-M(C7) | 17-4910 | |
| **MATT–** | | |
| 89 | 17-5438 | Nucl. Fusion, 2: 16-22(1962) |
| 95 | 17-4770 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 113 | 17-5472 | Phys. Fluids 5: 1272-7(1962) |
| 118 | 17-5464 | Nuovo Cimento (10), 26: 698-716(1962) |
| **MITNE–** | **(Misc.)** | |
| 8* | 17-4807 | $5.60(OTS) |
| **MLM–** | | |
| 1129 | 17-4374 | Dep.; $0.75(OTS) |
| 1133 | 17-4375 | Dep.; $0.75(OTS) |
| **NAA-SR–** | | |
| 7136 | 17-4628 | Dep.; $1.00(OTS) |
| **NASA-TN–** | **(Misc.)** | |
| D-1097* | 17-4808 | $0.50(OTS) |
| D-1532* | 17-5640 | $0.50(OTS) |
| **NDA–** | **(Misc.)** | |
| 2132-5 | 17-5579 | Dep.; $3.00(OTS) |
| **NDL-TM–** | **(Non-AEC)** | |
| 6 | 17-5412 | |
| **NMI–** | **(Misc.)** | |
| 7010 | 17-4930 | Dep.; $1.25(OTS) |
| 9700.3* | 17-4911 | $3.60(OTS) |
| **NP–** | **(AEC File No. for Non-AEC Reports)** | |
| 12236 | 17-4771 | $9.60(OTS) |
| 12239 | 17-5580 | |
| 12248 | 17-4809 | |
| 12250 | 17-4569 | |
| 12258 | 17-5322 | Dep.(mc) |
| 12260 | 17-5532 | |
| 12264 | 17-5641 | |
| 12270 | 17-5642 | |
| 12286 | 17-4691 | |
| 12306 | 17-4931 | $2.50(OTS) |
| 12334 | 17-4905 | |
| **NP-tr–** | **(AEC File No. for Non-AEC Translations)** | |
| 923 | 17-4775 | $1.60(fs), $0.80(mf) ICL |
| **NRC–** | **(Canadian)** | |
| 6996 | 17-4508 | Can. J. Phys. 40: 1279-93(1962) |
| 7001 | 17-5180 | Can. J. Phys. 40: 1319-31(1962) |
| **NRL–** | **(Misc.)** | |
| 5851* | 17-5300 | $1.10(OTS) |
| **NYO–** | | |
| 8921 | 17-5323 | Dep.(mc); $8.60(fs), $3.08(mf) OTS |
| 9286 | 17-5324 | Dep.(mc); $6.60(fs), $2.30(mf) OTS |
| 10206 | 17-5581 | Dep.; $1.75(OTS) |
| 10231 | 17-5189 | Nuovo Cimento (10) 26: 740-7(1962) |
| **ORNL–** | | |
| 349 | 17-4742 | Dep.(mc); $5.60(fs), $1.82(mf) OTS |
| 3294 | 17-4639 | Dep.; $2.00(OTS) |
| 3354 | 17-5034 | Dep.; $2.50(OTS) |
| 3364 | 17-5035 | Dep.; $3.00(OTS) |
| **ORNL-TM–** | | |
| 402 | 17-4661 | Dep.(mc); $3.60(fs), $1.28(mf) OTS |
| 413 | 17-4912 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 423 | 17-5413 | Dep.(mc); $2.60(fs), $0.89(mf) OTS |
| 435 | 17-4743 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **OTS–** | **(Misc.)** | |
| 60-51082 | 17-4917 | $4.25(OTS) |
| **PATENTS** | **(British)** | **3s. 6d. each, U. K. Patent Office** |
| 900,423 | 17-4487 | |
| 908,557 | 17-4684 | |
| 909,193 | 17-4755 | |
| 909,207 | 17-4861 | |
| 909,235 | 17-4876 | |
| 909,340 | 17-4652 | |
| 909,485 | 17-4797 | |
| 909,500 | 17-5589 | |
| 909,502 | 17-4919 | |
| 909,505 | 17-5590 | |
| 909,561 | 17-4685 | |
| 909,637 | 17-5591 | |
| 909,646 | 17-4653 | |
| 909,692 | 17-4756 | |
| 909,698 | 17-4920 | |
| 909,719 | 17-4862 | |
| 909,725 | 17-4921 | |
| 909,755 | 17-4555 | |
| 909,775 | 17-4654 | |
| 909,848 | 17-5592 | |
| 909,862 | 17-5593 | |
| 909,989 | 17-5162 | |
| 910,025 | 17-4623 | |
| 910,203 | 17-5594 | |
| 910,212 | 17-4556 | |
| 910,245 | 17-4798 | |
| 910,289 | 17-4557 | |
| 910,299 | 17-5595 | |
| 910,300 | 17-5596 | |

| Report No. | Abstract No. | Availability |
|---|---|---|
| 910,351 | 17-4655 | |
| 910,352 | 17-4656 | |
| 910,366 | 17-5597 | |
| 910,443 | 17-4636 | |
| 910,445 | 17-4657 | |
| 910,508 | 17-5598 | |
| 910,515 | 17-4658 | |
| 910,517 | 17-4922 | |
| 910,564 | 17-5599 | |
| 910,644 | 17-5600 | |
| 910,677 | 17-4686 | |
| 910,700 | 17-4987 | |
| 910,713 | 17-5601 | |
| **PATENTS** | **(U. S.)** | **$0.25 each, U. S. Patent Office** |
| 3,060,314 | 17-4799 | |
| 3,060,315 | 17-4768 | |
| 3,060,316 | 17-4800 | |
| 3,062,727 | 17-4901 | |
| 3,062,728 | 17-5602 | |
| 3,062,957 | 17-4863 | |
| 3,064,440 | 17-4801 | |
| 3,065,045 | 17-4624 | |
| 3,065,052 | 17-4558 | |
| 3,065,117 | 17-4988 | |
| 3,065,162 | 17-5603 | |
| 3,065,345 | 17-4864 | |
| 3,065,346 | 17-4865 | |
| 3,065,348 | 17-4866 | |
| 3,065,349 | 17-4867 | |
| 3,065,351 | 17-5529 | |
| 3,065,863 | 17-4659 | |
| 3,066,085 | 17-4619 | |
| 3,066,088 | 17-5632 | |
| 3,066,089 | 17-5604 | |
| 3,066,220 | 17-4488 | |
| 3,066,728 | 17-4620 | |
| 3,067,004 | 17-4637 | |
| 3,067,121 | 17-5605 | |
| 3,067,329 | 17-4868 | |
| 3,067,331 | 17-4869 | |
| 3,067,346 | 17-4802 | |
| 3,067,347 | 17-5427 | |
| 3,067,350 | 17-4870 | |
| 3,067,359 | 17-5428 | |
| 3,067,420 | 17-4803 | |
| **PIBMRI–** | **(Non-AEC)** | |
| 987-62 | 17-5439 | $3.60(OTS) |
| **PST-Cat.–** | **(Misc.)** | |
| 388 | 17-4917 | See OTS-60-51082 |
| **PUC–** | | |
| 1962-62 | 17-5325 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 1962-74 | 17-5383 | Phys. Rev. 128: 2708-16(1962) |
| 1962-79 | 17-5242 | Phys. Rev. 128: 2724-8(1962) |
| 1962-80 | 17-5384 | Phys. Rev. 128: 2728-38(1962) |
| **R–** | **(Misc.)** | |
| 2617-4* | 17-4905 | See NP-12334 |
| **RADC-TDR–** | **(Misc.)** | |
| 62-67* | 17-5042 | $1.60(OTS) |
| 62-106* | 17-5437 | See GCA-TR-62-8-A |
| **RFP–** | | |
| 253 | 17-4772 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **RM–** | **(Misc.)** | |
| 3058-NASA* | 17-5043 | $4.60(OTS) |

| Report No. | Abstract No. | Availability |
|---|---|---|
| 3391-PR* | 17-5044 | $2.60(OTS) |
| **RT-FI–** | **(Italian)** | |
| (62)10 | 17-5416 | Alta Freq. 30: 755-66(1961) |
| **RT-PROT–** | **(Italian)** | |
| (62)3 | 17-4649 | Rend. Ist. Super. Sanita 24: 858-70(1961) |
| (62)6 | 17-4694 | Comit. Naz. Energia Nucl., Notiziario 8: 10-14(1962) |
| **SCDC–** | | |
| 2488 | 17-5066 | See TID-16423 |
| 2518 | 17-4949 | See TID-15803 |
| 2553 | 17-4592 | See TID-14927 |
| 2933 | 17-4878 | See TID-17355 |
| **SCR–** | | |
| 512 | 17-4494 | Dep.; $2.25(OTS) |
| 529 | 17-5066 | See TID-16423 |
| 556 | 17-4449 | J. Chem. Educ. 39: 436-42(1962) |
| **SPNBE–** | **(French)** | |
| 7 | 17-5295 | See CEA-2156 |
| **TDR–** | **(Non-AEC)** | |
| 930(2210-03) TR-1 | 17-5435 | See DCAS-TDR-62-45 |
| 930(2210-04) TR-2 | 17-5434 | See DCAS-TDR-62-12 |
| 930(2220-40) TR-1 | 17-5639 | See DCAS-TDR-62-32 |
| 930(2230-03) TN-6 | 17-5436 | See DCAS-TDR-62-79 |
| **TID–** | | |
| 7027 | 17-4744 | Dep.; $2.50(OTS) |
| 7643 | 17-4570 | Dep.; $5.00(OTS) |
| 13114 | 17-4880 | J. Soc. Ind. Appl. Math. 10: 339-50(1962) |
| 13406 | 17-4462 | Advan. X-Ray Anal. 5: 379-88(1962) |
| 13610 | 17-5514 | p.1689-98 of "Proceedings of the Fifth International Conference on Ionization Phenomena in Gases, Munich 1961" Amsterdam, North-Holland Publishing Co., 1961 |
| 13632 | 17-4776 | Appl. Opt. 1: 407-9(1962) |
| 13633 | 17-5440 | Dep.(mc); $2.60(fs), $0.92(mf) OTS |
| 13710 | 17-5301 | Dep.(mc); $4.60(fs), $1.61(mf) OTS |
| 13772 | 17-4495 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 13972 | 17-4388 | Ann. Rev. Pharmacol. 2: 341-62(1962) |
| 14067 | 17-4389 | J. Mol. Biol. 4: 65-8(1962) |
| 14172 | 17-5337 | J. Inorg. & Nucl. Chem. 24: 337-41(1962) |
| 14272 | 17-4468 | Limnol. Oceanog. 7: 186-200(1962) |
| 14530 | 17-4645 | See LADC-5353 |
| 14594 | 17-5065 | Ann. Rev. Phys. Chem. 13: 281-304(1962) |
| 14703 | 17-5148 | Physica 28: 1007-10(1962) |
| 14735 | 17-4851 | Radiology 79: 1001-7(1962) |
| 14794 | 17-5045 | Dep.(mc); $3.60(fs), $1.25(mf) OTS |
| 14796 | 17-4773 | Dep.(mc); $5.60(fs), $1.76(mf) OTS |
| 14800 | 17-5108 | J. Mol. Spectr. 9: 130-7(1962) |
| 14840 | 17-5202 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 14912 | 17-4376 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 14927 | 17-4592 | Dep.(mc); $2.60(fs), $0.95(mf) OTS |
| 15179 | 17-5127 | Phys. Fluids 5: 1181-7(1962) |
| 15318 | 17-5422 | Nucl. Instr. Methods 17: 78-80(1962) |
| 15345 | 17-4787 | Proc. I.R.E. (Inst. Radio Engrs.) 50: 1523-4(1962) |
| 15404 | 17-5302 | Dep.(mc); $2.60(fs), $1.07(mf) OTS |
| 15405 | 17-5303 | Dep.(mc); $3.60(fs), $1.13(mf) OTS |
| 15465 | 17-4640 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 15587 | 17-4679 | Phys. Fluids 5: 1390-8(1962) |
| 15803 | 17-4949 | J. Appl. Phys. 33: 3224-32(1962) |
| 15822 | 17-5245 | Phys. Rev. 128: 2793-2807(1962) |
| 15848 | 17-5016 | Phys. Rev. 128: 2580-8(1962) |
| 15894 | 17-4832 | Nucl. Instr. Methods 17: 71-4(1962) |
| 16025 | 17-4530 | J. Chem. Phys. 37: 1853-65(1962) |

| Report No. | Abstract No. | Availability |
|---|---|---|
| 16198 | 17-5348 | Nucl. Instr. Methods 17: 177-80(1962) |
| 16423 | 17-5066 | ARS(Am. Rocket Soc.) J. 32: 1095-7(1962) |
| 16618 | 17-4956 | J. Appl. Phys. 34: 237-8(1963) |
| 16644 | 17-4839 | Nucl. Instr. Methods 17: 137-9(1962) |
| 16918 | 17-5134 | Phys. Rev. 128: 2639-54(1962) |
| 17266 | 17-4593 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 17355 | 17-4878 | Dep.(mc); $7.60(fs), $2.60(mf) OTS |
| 17362 | 17-4713 | To be published in IAEA Proceedings of the Symposium on Radioactive Dating, held in Athens, Greece, November 19–23, 1962 |
| 17365 | 17-4717 | For presentation at IAEA Symposium on Radioactive Dating, held at Athens, Greece, November 19–23, 1962 |
| 17367 | 17-4496 | Dep.(mc); $2.60(fs), $1.07(mf) OTS |
| 17369 | 17-4560 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 17370 | 17-5441 | Dep.(mc); $2.60(fs), $1.07(mf) OTS |
| 17372 | 17-4932 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 17377 | 17-4718 | For presentation at the IAEA Symposium on Radioactive Dating, held at Athens, Greece, November 19–23, 1962 |
| 17378 | 17-4641 | Dep.(mc); $9.10(fs), $3.32(mf) OTS |
| **UAC–** | | |
| 5792 | 17-4376 | See TID-14912 |
| 6849 | 17-5023 | See ANL-FGF-392 |
| 6888 | 17-4687 | See ANL-FGF-378 |
| 6907 | 17-4887 | See ANL-FGF-393 |
| **UCRL–** | | |
| 6355 | 17-5442 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 6388 | 17-5055 | Ann. Rev. Nuclear Sci. 11: 95-174(1961) |
| 6499 | 17-5203 | Dep.(mc); $3.60(fs), $1.25(mf) OTS |
| 6553 | 17-5643 | Dep.(mc); $2.60(fs), $1.01(mf) OTS |
| 6558-T | 17-5204 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 6559-T | 17-5205 | Dep.(mc); $8.10(fs), $2.69(mf) OTS |
| 6607 | 17-4644 | Control Eng. 9: 139(1962) |
| 6653-T | 17-5456 | J. Nucl. Energy, Pt. C, 4: 287-9(1962) |
| 6656 | 17-4512 | Chem. Eng. News 39: 39(1961) |
| 6728 | 17-5473 | Phys. Fluids 5: 1277-87(1962) |
| 6868 | 17-5508 | Proc. Phys. Soc. (London) 80: 309-11 (1962) |
| 6897-T | 17-5137 | Phys. Rev. 128: 2686-7(1962) |

| Report No. | Abstract No. | Availability |
|---|---|---|
| 6944 | 17-5135 | Phys. Rev. 128: 2671-5(1962) |
| 9583 | 17-4390 | Sci. Am. 206: 3-14(1962) |
| 9600 | 17-5062 | Ann. Rev. Nuclear Sci. 11: 419-38(1961) |
| 10052 | 17-5569 | Revs. Modern Phys. 34: 390-4(1962) |
| 10057 | 17-4829 | Nucl. Instr. Methods 17: 49-59(1962) |
| 10058 | 17-5570 | Revs. Modern Phys. 34: 394-401(1962) |
| 10102 | 17-4854 | Rev. Sci. Instr. 33: 741-3(1962) |
| 10104 | 17-4390 | See UCRL-9583 |
| 10123 | 17-5330 | Arkiv Fysik 23: 35-40(1962) |
| 10131(Rev.) | 17-4651 | Rev. Sci. Instr. 33: 877-8(1962) |
| 10201 | 17-5552 | Nuovo cimento (10) 26: 541-59(1962) |
| 10212 & Rev. | 17-5252 | Phys. Rev. Letters 9: 173-6(1962) |
| 10269 | 17-5492 | Phys. Fluids 5: 1482-3(1962) |
| 10272 | 17-5262 | Phys. Rev. Letters 9: 233-5(1962) |
| 10350 | 17-4561 | Dep.; $2.00(OTS) |
| 10363 | 17-5562 | Phys. Rev. 128: 2898(1962) |
| 10451 | 17-4497 | Dep.; $1.75(OTS) |
| 10460 | 17-4498 | Dep.; $2.50(OTS) |
| 10474 | 17-5326 | Dep.(mc); $0.50(OTS) |
| 10477 | 17-5046 | Dep.; $2.25(OTS) |
| 10479 | 17-4380 | Dep.; $1.25(OTS) |
| 10482 | 17-4499 | Dep.; $2.00(OTS) |
| 13054 | 17-4692 | Dep.(mc); $5.60(fs), $2.00(mf) OTS |
| **UCRL-Trans–** | | |
| 852(L) | 17-5048 | Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS |
| 853(L) | 17-5049 | Dep.(mc); $2.60(fs), $0.98(mf) JCL or OTS |
| 876(L) | 17-4642 | Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS |
| **WADD-TR–** | **(Non-AEC)** | |
| 60-463(Pt.II) | 17-4933 | OTS |
| 60-676(Pt.II) | 17-5443 | $1.50(OTS) |
| **WAPD-T–** | | |
| 1305 | 17-5206 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 1393 | 17-4882 | SIAM (Soc. Ind. Appl. Math.) Rev. 4: 115-34(1962) |
| **Y-KB–** | | |
| 22 | 17-4745 | Dep.(mc); $2.60(fs), $1.01(mf) OTS |
| **ZPh–** | **(Non-AEC)** | |
| 084 | 17-5644 | |

S92 Room 2nd floor IS